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U.S. Department of Labor
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Fall 2002

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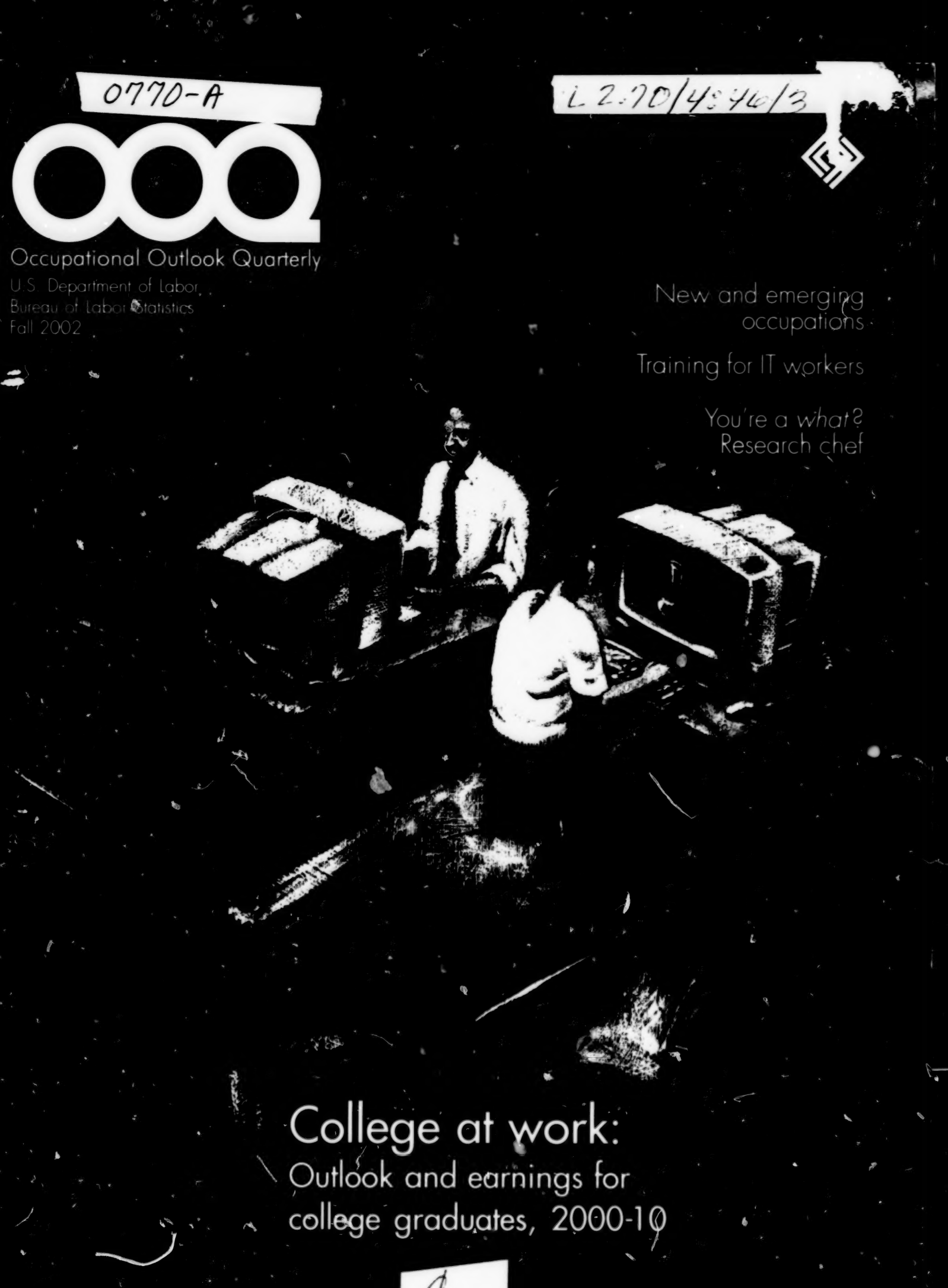

College at work:
Outlook and earnings for college graduates, 2000-10

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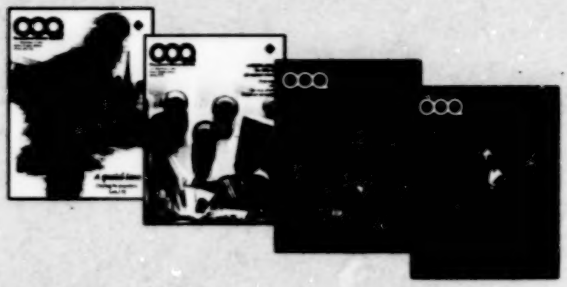

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I

Occupational Outlook Quarterly

Fall 2002
Volume 46, Number 3

College appeals to more people than ever before. What awaits these graduates? Will the workplace pay?

College at work:

Outlook and earnings for college graduates, 2000-10

by Arlene Dohm and Ian Wyatt

When it comes to work, having a college degree is one of the best ways to gain and maintain a competitive edge. On average, college graduates enjoy advantages—ranging from more job opportunities to better salaries—over their non-college-educated counterparts.

A college degree does not guarantee that workers will find their dream job, but it does help prepare them for career pursuits. And the goal of career preparation is at least part of the reason that more than 1 million students earned their bachelor's degrees in 2000.

What are the job prospects for these college graduates? This article considers that question by presenting an overview of the 2000-10 job market for college graduates. The first section examines education and employment data, reasons for attending college, and earnings data. The second section describes the background for the Bureau of Labor Statistics (BLS) publication of the outlook for college graduates, including information about why this article differs markedly from those of years past; projects the number of job openings in occupations that employ the largest numbers of college graduates; and compares growth in these jobs with the projected average employment growth for all occupations. A final section points up sources for further research.

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For purposes of this article, the term "college degree" refers to any bachelor's or higher degree: master's, including master of business administration; professional, such as law; and doctor of philosophy, or Ph.D. Data are examined by workers' highest levels of educational attainment—from high school diploma to Ph.D.

College in career planning

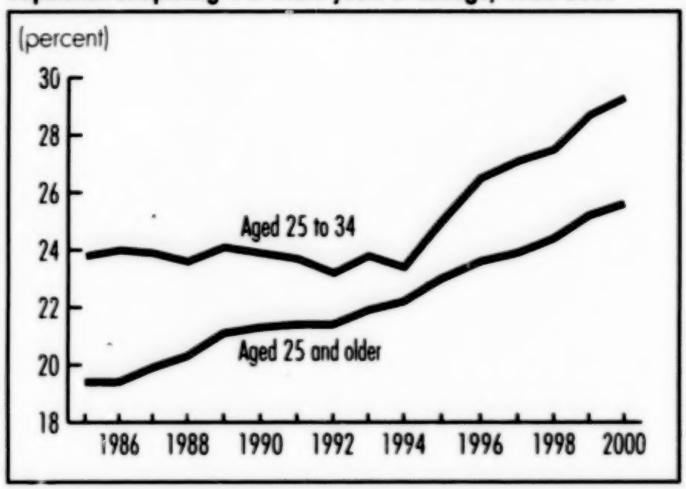
People attend college for many reasons. Some of those reasons are personal—the quest for self-improvement, perhaps—while others are universal, tied to a desire to enter occupations in which a college degree may be preferred or even required for workers. Although it is impossible to discern each student's motivation for going to college, one thing is certain: more individuals are earning their degrees. And as a career-planning tool, those degrees have some quantifiable benefits, the most measurable of which are earnings.

More people have college degrees

Over the last several decades, there has been an increase in the proportion of people earning a degree. This increase is particularly striking in recent years for those aged 25 to 34. (See chart 1.) Overall for people in this age group, Census Bureau data show that the proportion completing 4 or more years of college grew from 23 percent in 1992 to 29 percent in 2000. College-educated workers are even more prevalent.

Chart 1

Population completing 4 or more years of college, 1985-2000



Data show that during that same 8-year period, the proportion of the workforce with college degrees increased from 25 percent to 28 percent. Among workers 25 to 34 years old, the proportion rose from 26 percent to 33 percent. A base year of 1992 is used because it was the first year in which the Current Population Survey collected educational attainment data based on the highest degree earned; prior to 1992, educational attainment data reflected only the number of years of schooling completed.

Within the college-educated workforce, immigrants are a significant presence. In 2000, foreign-born college graduates made up 12 percent of the college-graduate labor force. Current Population Survey data show that among immigrants aged 25 to 34 who entered this country between 1996 and 2000 and are in the labor force, 38 percent have a college degree, including 16 percent with an advanced degree. In contrast, 32 percent of U.S.-born workers aged 25 to 34 have a college degree, including 7 percent with an advanced degree.

At any given time, a portion of college graduates is unavailable to fill jobs. These college graduates—ones who are neither working nor looking for work—are, by definition, not in the labor force. In 2000, the civilian labor force participation rate of individuals aged 25 to 34 with a college degree was 89 percent—which means another 11 percent of college graduates in that age group were not in the labor force. Some go to graduate school without taking a supplemental job. Others stay home to raise a family. Still others enter the military. For most college graduates, their time out of the labor force is usually temporary; most will work for much of their lives.

Benefits of a college degree

For most people, pursuing a college degree is both time consuming and expensive. But in the end, college graduates usually see a return on their investments of time and money. Students working toward a degree are likely to set their sights on the long-term payoffs—which include more career options, better promotion opportunities, higher earnings, and lower unemployment—that a college education provides.

More career options. Many occupations may be classified as "college preferred"—that is, a college degree is helpful, but not mandatory, in obtaining the job. But there are a number of occupations that only a college graduate can hold. Some may require several years of additional education beyond a bachelor's degree, leading to a graduate or professional degree, and a license to practice. Among the largest of these are health diagnosing and treating occupations, including physicians, dentists, and veterinarians; teachers and faculty; and lawyers.

College-preferred occupations do not necessarily specify a preference for field of study. As a result, college graduates' career options include entering occupations unrelated to their major. A 1997 survey by the U.S. Department of Education's National Center for Education Statistics found that, 4 years after obtaining a bachelor's degree, 55 percent of graduates were in jobs related to their major field of study. Social sciences majors had the lowest proportion, 33 percent, of jobs related to their field of study. In contrast, 82 percent of those who majored in the rapidly growing health-related fields held jobs related to their major. (For more information on the survey, see "Four years after graduation: The class of 1993," in the Winter 2000-01 *Occupational Outlook Quarterly*, also available online at **www.bls.gov/opub/ooq/2000/winter/art02.pdf**.)

Better promotion opportunities. Job promotions usually are based on workers' motivation, quality of work, and ability to get along with others. But supervisors often interpret having a college degree as a sign that workers are serious about the job, know how to learn, and can achieve goals. Supervisors considering candidates for promotion may look more favorably upon those who have a college degree than on those who do not have one. For example, in 2000, 24 percent of supervisors in administrative support and clerical occupations had a college degree, even though college graduates are only 14 percent of the workers in this occupational group as a whole. Similarly, 32 percent of supervisory police and detectives in 2000 held a college degree, despite college graduates being 21 percent of nonsupervisory police and detectives.

Higher earnings. The ability to earn a high salary over a

lifetime is one of the most compelling reasons to earn a degree. Among the top 25 percent of full-time wage and salary earners in 2000, 58 percent had a college degree. The median weekly earnings of workers aged 25 to 64 with a bachelor's degree was $834, compared with $507 for workers whose highest level of educational attainment was a high school diploma or equivalent. Earnings increased for those with advanced degrees. But not all college graduates earn high salaries; in fact, 17 percent of these bachelor's degree holders earned less than the median for all high school graduates in 2000. Nevertheless, data show that most college graduates earn more than workers whose highest level of educational attainment is a high school diploma.

The following tabulation shows the 2000 median weekly earnings of workers aged 25 to 64 by highest level of educational attainment and the proportions of those workers who earned less than the median for high school graduates:

Education level	*Median weekly earnings, 2000*	*Percent who earned less than the median for high school graduates*
High school diploma or equivalent	$507	–
Bachelor's degree	834	17
Master's degree	983	10
Professional degree	1,174	9
Doctoral degree	1,214	6

The link between earnings and education is discussed in more detail below, in the section "Earnings: Higher by degree." (And for a look at the increase in estimated lifetime earnings by educational attainment, see the OOChart in this issue of the *Quarterly*.)

Lower unemployment. The chances of having a job are better for those with a college degree than for those without one—and the unemployment rate is lower for those with more education. As chart 2 shows, the unemployment rate in 2000 was 3.5 percent for workers aged 25 and over whose highest level of educational attainment was a high school diploma, compared with less than 1 percent for those who had either a professional or doctoral degree.

Earnings: Higher by degree

Earnings are an indicator of the demand for college graduates because wages tend to increase fastest for workers in greatest demand. And between 1992 and 2000, real earnings—median earnings adjusted for inflation—rose 6 percent for full-time wage and salary workers aged 25 to 64 with a bachelor's degree. In contrast, real earnings increased only 2 percent for their counterparts whose highest level of educational attainment was a high school diploma. More remarkably, wages increased despite a 33-percent increase in the number of college graduates aged 25 to 64 and working full time, far surpassing the 4-percent increase in the number of workers with a high school diploma.

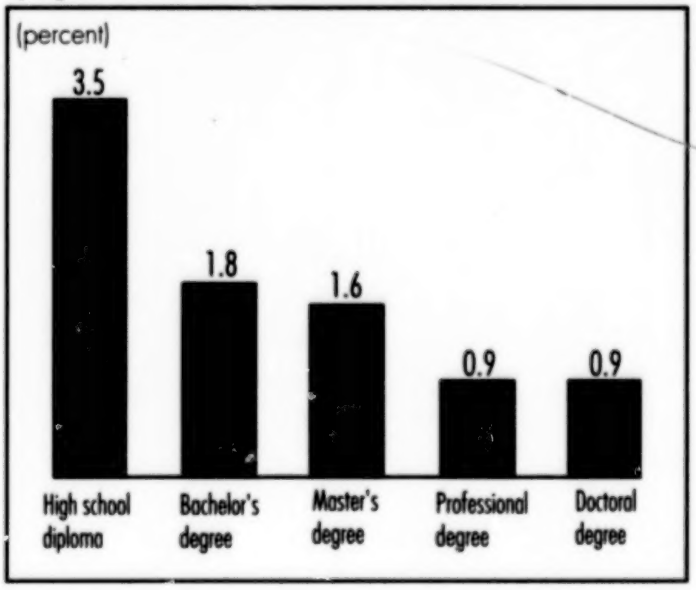
At the same time, however, wage increases became less evenly distributed among college graduates. The difference in real weekly earnings between the lowest earning (10th percentile) bachelor's degree holders and the highest (90th percentile) increased from $1,075 in 1992 to $1,297 in 2000—that translates to nearly $11,500 annually. (See chart 3.) Bachelor's degreeholders in the top 10 percent earned 16 percent more in 2000 than they did in 1992, while earnings for those in the lowest 10 percent increased only 5 percent during the 8-year period.

The widening disparity in earnings for all educational groups implies that earnings are determined by factors other than education. These factors include the State and city in which the job is located, how large the company is, and whether the job is in the public sector or private sector. Experience and occupation also affect earnings.

The more experience workers have, the higher their earnings usually are. Having experience plus a degree

Chart 2

Unemployment of workers aged 25 and over by highest level of educational attainment, 2000

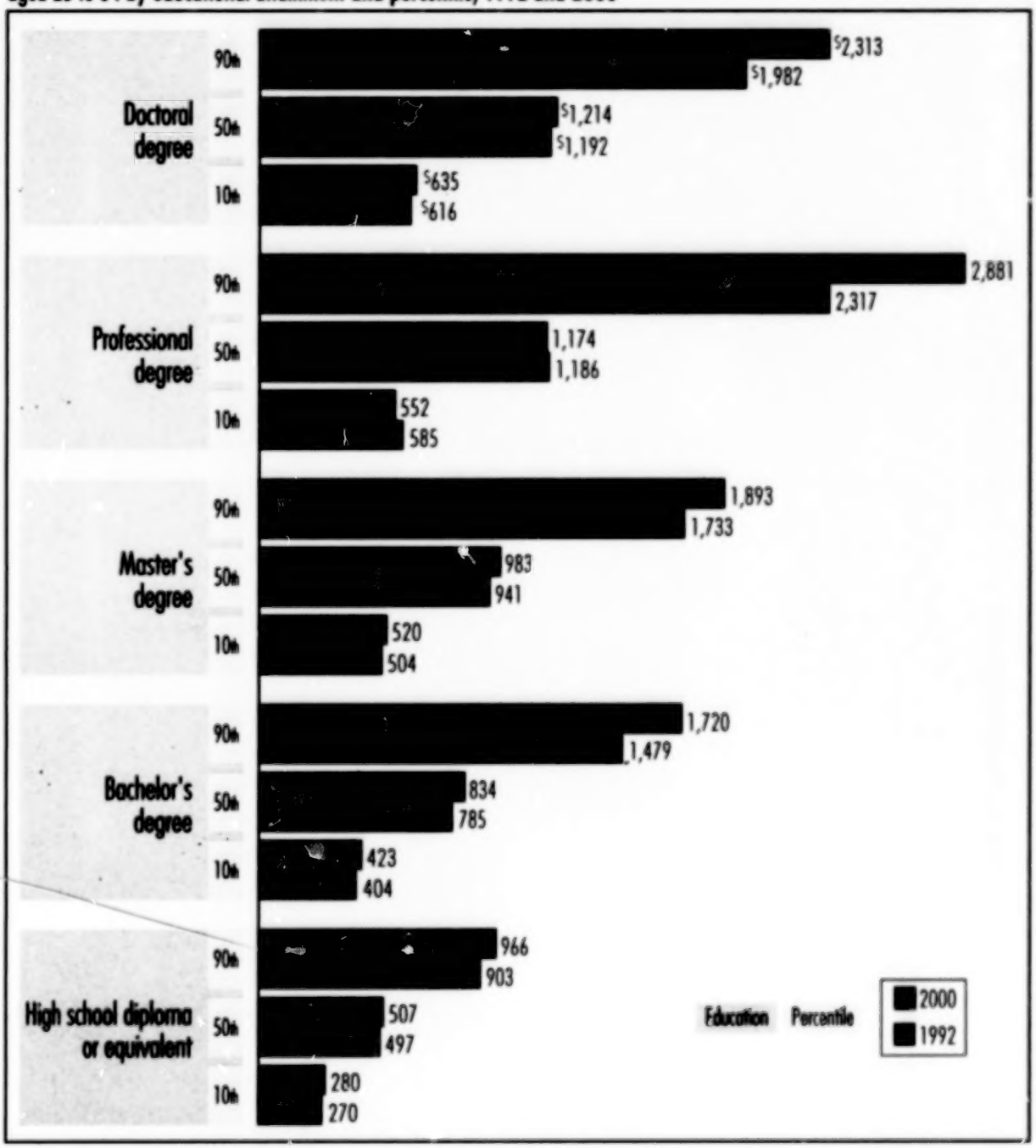


enhances a worker's ability to qualify for promotions and positions of responsibility, leading to higher salaries. And in occupations in which establishing a client base is required to earn top salaries—some sales jobs, for example—the longer a worker remains in an occupation, the more lucrative it becomes.

Experience contributes to salary variations within occupations, even those that have high salaries. Engineers' weekly earnings in 2000, for example, ranged from at least $1,782 for the top 10 percent to less than $608 for the lowest 10 percent. Chart 4 shows the wide dispersion of earnings within some other occupations in which most workers hold a college degree.

Chart 3

Real weekly earnings of full-time wage and salary workers aged 25 to 64 by educational attainment and percentile, 1992 and 2000



The level of educational attainment and field of study also affect one's earnings power. Physicians, lawyers, and top executives usually command high salaries, reflecting their extra schooling and responsibilities. And even within an occupation, earnings increase for workers who pursue additional education. For example, as table 1 shows, the median weekly earnings for administrators in education and related fields in 2000 were $764 for those with a bachelor's degree, $1,105 for those with a master's degree, and $1,250 for those with a doctoral degree.

Workers' choice of occupation affects earnings potential, too. Table 1 also shows that in 2000, weekly earnings for architects with a bachelor's degree—the highest level of education for most workers in that occupation—were $1,159, nearly 42 percent more than the $817 weekly earnings for librarians with a master's degree, who were the majority in that occupation.

Analyzing the college graduate outlook, 2000-10

As data in the previous section showed, earning a college degree is an attractive option for many people. Will this trend continue into the next decade? To explore this question, the

Continued on page 10

Chart 4

Usual weekly earnings of full-time wage and salary workers aged 25 to 64 in selected occupations, 2000

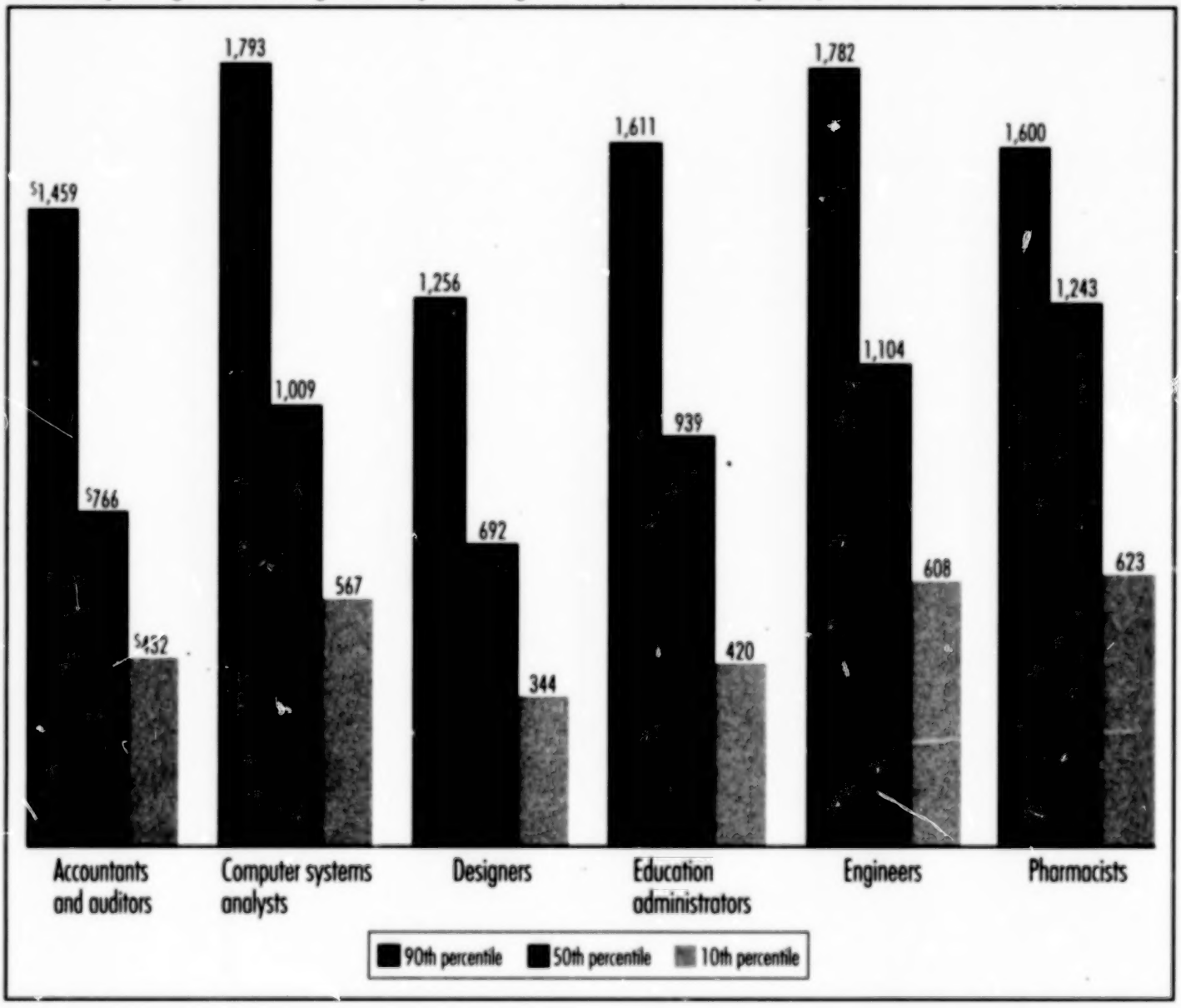


Table 1

Median weekly earnings of workers in selected occupations by highest level of educational attainment, 2000

Occupation	Highest level of educational attainment									
	High school diploma or equivalent		Bachelor's or higher degree (all levels)		Bachelor's degree		Master's degree		Professional degree or Ph.D.	
	Share of occupation (percent)	Median earnings	Share of occupation (percent)	Median earnings	Share of occupation (percent)	Median earnings	Share of occupation (percent)	Median earnings	Share of occupation (percent)	Median earnings
All occupations	**31**	**$507**	**31**	**$897**	**21**	**$834**	**7**	**$983**	**3**	**$1,197**
Accountants and auditors	7	578	72	921	57	876	14	1,118	–	–
Actors and directors	–	–	66	1,092	55	1,078	–	–	–	–
Administrators and officials, public administration	15	732	57	1,025	33	901	20	1,124	–	–
Administrators, education and related fields	8	498	77	1,042	22	764	43	1,105	11	1,250
Advertising and related sales occupations	–	–	53	970	48	990	–	–	–	–
Aerospace engineers	–	–	84	1,276	–	–	–	–	–	–
Airplane pilots and navigators	–	–	77	1,441	70	1,436	–	–	–	–
Architects	–	–	89	1,134	54	1,159	30	1,103	–	–
Assemblers	52	468	6	460	5	478	–	–	–	–
Authors	–	–	80	882	49	765	–	–	–	–
Biological and life scientists	–	–	99	869	–	–	–	–	–	–
Bookkeepers, accounting, and auditing clerks	40	477	14	562	12	551	–	–	–	–
Buyers, wholesale and retail trade, except farm products	29	505	32	934	29	943	–	–	–	–
Carpenters	49	614	5	721	4	714	–	–	–	–
Cashiers	50	303	8	384	7	372	–	–	–	–
Chemical engineers	–	–	90	1,265	–	–	–	–	–	–
Chemists, except biochemists	–	–	90	984	47	884	–	–	–	–
Civil engineers	–	–	83	1,095	55	1,019	25	1,256	–	–
Clergy	–	–	78	742	23	790	42	698	–	–
Clinical laboratory technologists and technicians	–	–	46	713	42	700	–	–	–	–
Computer programmers	10	864	63	1,039	49	1,019	12	1,087	–	–
Computer systems analysts and scientists	6	887	72	1,132	51	1,081	18	1,243	–	–
Cooks	44	327	5	396	4	386	–	–	–	–
Counselors, educational and vocational	–	–	90	827	24	725	60	842	–	–
Data processing equipment repairers	23	686	26	725	21	721	–	–	–	–
Data-entry keyers	45	475	13	514	12	510	–	–	–	–
Dentists	–	–	99	1,310	–	–	–	–	91	1,508
Designers	16	633	50	794	43	771	–	–	–	–
Economists	–	–	83	965	50	799	–	–	–	–
Editors and reporters	–	–	80	830	62	803	–	–	–	–
Electrical and electronic engineers	–	–	74	1,242	49	1,170	21	1,350	–	–
Electrical and electronic technicians	22	701	20	817	18	782	–	–	–	–
Electricians	41	714	7	976	–	–	–	–	–	–
English teachers	–	–	96	1,010	–	–	–	–	–	–
Farmers, except horticultural	47	452	18	450	14	450	–	–	–	–
Financial managers	13	611	63	1,222	45	1,125	16	1,432	–	–
General office clerks	45	459	15	585	12	552	–	–	–	–
Guards and police, except public service	43	467	14	592	12	563	–	–	–	–

Table 1 (continued)

Median weekly earnings of workers in selected occupations by highest level of educational attainment, 2000

Occupation	Highest level of educational attainment									
	High school diploma or equivalent		Bachelor's or higher degree (all levels)		Bachelor's degree		Master's degree		Professional degree or Ph.D.	
	Share of occupation (percent)	Median earnings	Share of occupation (percent)	Median earnings	Share of occupation (percent)	Median earnings	Share of occupation (percent)	Median earnings	Share of occupation (percent)	Median earnings
Industrial engineers	–	–	63	$1,070	48	$1,072			–	–
Inspectors and compliance officers, except construction	–	–	51	900	38	895	–	–	–	–
Insurance adjusters, examiners, and investigators	31	$517	30	673	26	683	–	–	–	–
Insurance sales occupations	21	537	47	891	41	889	–	–	–	–
Investigators and adjusters, except insurance	38	482	19	577	17	579	–	–	–	–
Janitors and cleaners	47	374	4	398	3	404	–	–	–	–
Lawyers	–	–	99	1,331	–	–	–	–	89	$1,356
Legal assistants	21	563	37	725	30	711	–	–	–	–
Librarians	–	–	77	750	28	575	46	$817	–	–
Management analysts	–	–	72	1,263	41	1,238	26	1,388	–	–
Managers, food serving and lodging establishments	34	540	26	800	22	799	–	–	–	–
Managers, marketing, advertising, and public relations	10	802	67	1,306	52	1,208	15	1,527	–	–
Managers, medicine and health	15	556	51	958	31	897	16	1,047	–	–
Managers, properties and real estate	28	574	35	893	28	896	–	–	–	–
Managers, service organizations n.e.c.	17	520	59	881	38	830	19	915	–	–
Mechanical engineers	–	–	74	1,193	53	1,117	19	1,452	–	–
Medical scientists	–	–	92	840	–	–	–	–	–	–
Musicians and composers	–	–	55	781	–	–	–	–	–	–
Nursing aides, orderlies, and attendants	46	342	6	386	5	393	–	–	–	–
Operations and systems researchers and analysts	–	–	58	1,010	39	984	–	–	–	–
Other financial officers	14	628	60	1,072	46	951	13	1,337	–	–
Painters, sculptors, craft artists, and artist printmakers	–	–	52	739	40	736	–	–	–	–
Personnel and labor relations managers	–	–	59	1,107	42	1,007	–	–	–	–
Personnel, training, and labor relations specialists	15	599	52	849	7	806	12	963	–	–
Pharmacists	–	–	96	1,260	63	1,270	–	–	–	–
Photographers	–	–	57	744	45	729	–	–	–	–
Physical therapists	–	–	88	942	48	936	37	964	–	–
Physicians	–	–	99	1,361	–	–	–	–	92	1,432
Police and detectives, public service	20	726	29	886	26	867	–	–	–	–
Postsecondary teachers, subject not specified	–	–	94	896	20	601	31	749	43	1,090
Psychologists	–	–	93	848	–	–	45	745	35	1,097
Public relations specialists	–	–	75	825	55	786	–	–	–	–
Purchasing agents and buyers n.e.c.	28	658	31	891	27	838	–	–	–	–
Purchasing managers	–	–	48	1,092	–	–	–	–	–	–
Real estate sales occupations	18	614	43	918	35	894	–	–	–	–
Receptionists	49	407	10	418	9	420	–	–	–	–

Continued from page 7

following section analyzes projected job openings for college graduates between 2000 and 2010. The analysis begins with an explanation of how employment projections were created and ends with a discussion of how occupational changes affect the job outlook for college graduates.

Background

The Office of Occupational Statistics and Employment Projections of BLS develops employment projections for hundreds of detailed occupations. These projections are used in a variety of occupational studies, including these analyses of the job outlook for college graduates. The first such

Table 1 (continued)

Median weekly earnings of workers in selected occupations by highest level of educational attainment, 2000

	Highest level of educational attainment									
	High school diploma or equivalent		Bachelor's or higher degree (all levels)		Bachelor's degree		Master's degree		Professional degree or Ph.D.	
Occupation	Share of occupation (percent)	Median earnings	Share of occupation (percent)	Median earnings	Share of occupation (percent)	Median earnings	Share of occupation (percent)	Median earnings	Share of occupation (percent)	Median earnings
Registered nurses	–	–	55	$866	45	$838	8	$1,004	–	–
Religious workers n.e.c.	–	–	58	677	–	–	–	–	–	–
Sales occupations, other business services	21	$587	46	954	38	933	–	–	–	–
Sales representatives, mining, manufacturing and wholesale	21	627	45	961	40	946	5	1,247	–	–
Sales workers, motor vehicles and boats	41	726	21	730	19	759	–	–	–	–
Sales workers, other commodities	38	350	25	650	21	661	–	–	–	–
Sales workers, radio, television, hi-fi, and appliances	–	–	39	1,071	–	–	–	–	–	–
Secretaries	44	453	10	490	9	490	–	–	–	–
Securities and financial services sales occupations	–	–	71	1,146	53	1,094	14	1,395	–	–
Social workers	8	507	73	660	42	612	29	753	–	–
Speech therapists	–	–	97	818	–	–	79	806	–	–
Street and door-to-door sales workers	25	410	32	674	23	777	–	–	–	–
Supervisors, construction	44	788	12	881	10	867	–	–	–	–
Supervisors and proprietors, sales occupations	34	550	29	860	24	828	4	1,094	–	–
Supervisors, general office	29	564	25	739	20	699	–	–	–	–
Supervisors, production occupations	45	655	14	982	11	971	–	–	–	–
Teacher aides	38	323	18	387	15	381	–	–	–	–
Teachers, except postsecondary	14	572	59	799	39	744	18	895	–	–
Teachers, elementary school	–	–	93	745	54	670	37	869	–	–
Teachers, prekindergarten and kindergarten	15	289	56	701	38	625	18	823	–	–
Teachers, secondary school	–	–	95	809	47	719	45	895	–	–
Teachers, special education	–	–	93	737	42	637	50	826	–	–
Transportation ticket and reservation agents	26	511	25	521	22	576	–	–	–	–
Truckdrivers	52	592	5	691	4	688	–	–	–	–
Veterinarians	–	–	98	1,018	–	–	–	–	–	–
Waiters and waitresses	46	308	10	394	9	396	–	–	–	–

Note: The data include only full-time, year-round workers aged 24 to 65.
Source: Current Population Survey

– = Data not shown where survey respondents number fewer than 50,000
n.e.c. = not elsewhere classified

analysis was published in the *Occupational Outlook Quarterly* in 1968, and updates have appeared nearly biennially since then. Past articles projected whether there would be an imbalance between the supply of and demand for college graduates in the workforce over the projections period.

However, the method used in recent years for projecting the number of job openings for college graduates is no longer feasible. Recent changes in occupational definitions resulted in a break in historical continuity. The latest employment projections, which cover the 2000-10 decade, were developed using the Federal Government's 2000 Standard Occupational Classification System. The 1990 census-based Current Population Survey, the source of data on educational attainment, has not yet converted to this new occupational classification system. Thus, comparable data on the proportions of occupations usually filled by college graduates—the basis for analyzing the demand for college graduates—no longer exist for all occupations. (See box at right.)

Another factor complicating the analysis of the college-graduate outlook is the ever-changing notion of which jobs require a college degree. Many occupations previously considered to require that all workers have a college degree included significant proportions of workers whose highest levels of educational attainment are an associate degree or, in some cases, a high school diploma. Few occupations actually require that all workers have a college degree to perform their duties. Instead, many occupations now are categorized as college preferred.

BLS will continue to reevaluate its method of assessing the outlook for college graduates in the future.

Projected job openings for college graduates

Over the next decade, the availability of jobs for college graduates will depend both on employment growth in occupations that usually are filled by college graduates and on the need to replace college graduates who permanently leave an occupation.

Job growth. BLS projects that overall employment will grow 15 percent between 2000 and 2010, resulting in 22 million new jobs. Much of this growth is projected to be in occupations in which large numbers of college graduates are employed. Among major occupational groups, the professional and related occupations group is projected to increase its relative share of employment by 2010. This group is projected to grow faster (26 percent) and add more workers (7 million) than any other group. About 80 percent of its workers aged 25 to 34 are college graduates, and nearly half

Comparison of occupational classification systems

The following box compares the major occupational groups that compose two occupational classification systems—the Current Population Survey (CPS) and the Standard Occupational Classification System (SOC). In this article, data on educational attainment are based on the CPS, and data on employment and job openings are based on the SOC.

Current Population Survey (CPS)	Standard Occupational Classification (SOC)
Executive, administrative, and managerial occupations	Management, business, and financial occupations (includes farm manager, which CPS classifies under farming, forestry, and fishing occupations)
Professional specialty occupations	Professional and related occupations (includes technicians)
Technicians and related support occupations	
Sales occupations	Sales and related occupations
Service occupations	Service occupations
Administrative support occupations, including clerical	Office and administrative support occupations
Farming, forestry, and fishing occupations	Farming, fishing, and forestry occupations
	Construction and extraction occupations (CPS classifies this group under precision production, craft, and repair occupations)
Precision production, craft, and repair occupations	Installation, maintenance, and repair occupations (CPS classifies this group under precision production, craft, and repair occupations)
Operators, fabricators, and laborers	Production occupations (CPS classifies this group under precision production, craft, and repair occupations and operators, fabricators, and laborers)
	Transportation and material moving occupations (CPS classifies this group under operators, fabricators, and laborers)

of all graduates are employed in this group.

Occupations employing primarily college graduates are projected to be among the fastest growing in the Nation. Table 2 shows projected job growth in occupations in which college graduates make up at least 50 percent of the workforce. These occupations employ at least 50,000 workers and are reasonably comparable between the two occupational classification systems—the Standard Occupational Classification System and the Current Population Survey—permitting an occupation's growth rate to be associated with its workers' educational attainment. Of the 43 occupations in the table, 33—77 percent—are projected to grow faster than the 15-percent increase projected for all occupations through 2010.

Replacement needs. The most significant source of demand for all workers, including college graduates, over the next decade will come not from job growth but from net replacement needs: the need to replace workers who permanently leave their occupations. For all education levels, job openings from replacement needs are projected to total 35 million between 2000 and 2010—48 percent more than the job openings resulting from employment growth. About 6 million

Table 2

Employment growth in occupations in which at least 50 percent of workers have a bachelor's or higher degree, 2000 and projected 2000-10

(Numbers in thousands)

Occupation*	Employment, 2000	2010, projected	Percent change, projected
Total, all occupations	**145,594**	**167,754**	**15**
Computer systems analyst and scientist	459	729	59
Physician assistant	58	89	54
Public relations specialist	137	186	36
Therapist	439	584	33
Manager, marketing, advertising, and public relations	707	936	32
Medical and health services manager	250	330	32
Veterinarian	59	77	32
Social worker	468	609	30
Technical writer	57	74	30
Management analyst	501	646	29
Author	126	162	28
Actor, producer, and director	158	200	27
Advertising sales agent	155	196	26
Registered nurse	2,194	2,755	26
Counselor, educational and vocational	205	257	25
Pharmacist	217	270	24
Teacher, college and university	1,344	1,659	23
Securities and financial services sales occupations	367	449	22
Architect	124	150	21
Biological and life scientist	184	218	21
Accountant and auditor	976	1,157	19
Dietitian and nutritionist	49	56	19
Financial manager	658	780	19
Teacher, special education	453	592	19
Lawyer	681	803	18
Personnel, training, and labor relations specialist	490	578	18
Physical scientist	423	501	18
Physician	598	705	18
Social scientist and related occupations	410	492	18
Teacher, prekindergarten and kindergarten	597	707	18
Teacher, secondary school	1,113	1,314	18
Photographer	131	153	17
Computer programmer	585	680	16
Clergy	171	197	15
Education administrator	453	513	13
Human resources manager	219	246	13
Librarian	149	160	12
Teacher, elementary school	2,122	2,381	12
Airplane pilot and navigator	117	129	10
Engineer	1,465	1,603	9
Operations research analyst	47	51	8
Dentist	152	161	6
Editor and reporter	78	80	3

*For these occupations, the definitions are generally comparable between the Current Population Survey and Standard Occupational Classification Manual (SOC). The occupational titles and growth rates are based on the SOC.

openings from replacement needs are projected to be in occupations in which a significant proportion of workers has a college degree.

Millions of older workers, including a high proportion of baby boomers with college degrees, are expected to retire by 2010, leaving a large number of job vacancies to be filled by college graduates. For example, educators were hired in large numbers in the 1960s and 1970s to teach the baby boomers, and many of these educators will be eligible to retire over the 2000-10 decade. (For an article about baby-boom retirements and job openings based on the previous set of employment projections, 1998 to 2008, see "Gauging the labor force effects of retiring baby boomers," in the July 2000 *Monthly Labor Review*, also available online at **www.bls.gov/opub/mlr/2000/07/art2full.pdf**.)

Growth and replacement: A summary. Projected job openings for college graduates may be summarized by examining the two major occupational groups that employ the most college graduates—management, business, and financial occupations and professional and related occupations. In 2000, 72 percent of all college graduates were employed in these two groups, making the employment projections for these groups critical to the overall job outlook for college graduates.

To determine the potential number of job openings for college graduates in each of these two occupational groups, BLS analysts multiplied the proportion of the group's 25- to 34-year-old workers with a degree in 2000—those most recently hired—by the total number of openings expected from growth and net replacement needs in the group between 2000 and 2010. The following tabulation shows the results of these calculations in managerial and professional occupations:

Occupational group	*Total job openings due to growth and net replacements, projected 2000-10*	*Proportion of 25- to 34-year-olds with college degree in occupational group*	*Potential job openings for college graduates*
Management, business, and financial occupations	5,109,000	56.5	2,886,600
Professional and related occupations	12,160,000	81.5	9,910,400

The potential number of job openings for college graduates in these two groups is nearly 13 million, which represents 22 percent of the 58 million job openings stemming from employment growth and net replacement needs projected for the entire economy over the 2000-10 decade. This number may well be an underestimate because the calculation assumes that the proportion of college graduates in each occupational group remains constant—and it is reasonable to expect that, given the increase in educational attainment in recent years, the proportion of graduates will rise in each of these groups.

These 13 million potential job openings exclude college graduates in some increasingly college-preferred occupations, particularly sales. With about 37 percent of 25- to 34-year-old college graduates holding jobs in this category, sales is becoming a career choice for many college graduates, especially in the business and financial, advertising, and technology fields. However, most sales workers are employed in retail and services—jobs that are filled by relatively few college graduates.

College in the workforce: Educational upgrading

Between 1992 and 2000, the number of full-time wage and salary workers with a college degree increased 33 percent. In response to this growing availability of college graduates, their proportions in many occupations are growing. But some occupations have experienced greater than average increases in college graduates, signifying either employer preferences or changes in those occupations. This increasing level of educational attainment in specific occupations is called educational upgrading.

Educational upgrading has been particularly noticeable in the health and protective service occupations and in occupations that usually are considered desirable and well paid, such as airline pilot and flight attendant. Flight attendant, for example, is an occupation that offers relatively high salaries and popular benefits, such as travel and the opportunity to experience other cultures. College graduates, especially younger ones, are attracted to the occupation: in 2000, 44 percent of flight attendants aged 25 to 34 held a bachelor's degree. This compares with 28 percent of all flight attendants with a college degree.

There are many reasons for educational upgrading, including the need for more highly skilled workers to compete in an increasingly complex global economy. Growing competition has forced companies to emphasize sales and customer service and, thus, to seek employees with strong communication skills. Employers often feel that, compared to non-college-educated workers, college graduates are more motivated, learn tasks more quickly, are better able to meet deadlines, and have better problemsolving and

Table 3

Changes in educational attainment, 1992-2000

(percent)

Occupation	Share of employment in occupational group[1]		Workers aged 25 to 34 with bachelor's or higher degree		Workers aged 25 to 34 with advanced degree	
	1992	2000	1992	2000	1992	2000
Total, all workers	**100**	**100**	**26**	**33**	**6**	**8**
Executive, administrative, and managerial occupations	13	15	49	57	9	12
Professional specialty occupations	14	16	76	82	29	30
Engineer, architect, and surveyor			83	84	23	23
Mathematical and computer scientist			74	76	20	18
Natural scientist			90	94	45	44
Health diagnosing occupations			97	99	95	97
Health assessment and treating occupations			62	71	14	20
Registered nurse			55	63	8	7
Therapist			73	82	28	48
Teacher, college and university			94	98	66	72
Teacher, except college and university			82	87	22	27
Social scientist and urban planner			81	91	42	46
Writer, artist, entertainer, and athlete			56	69	10	9
Technicians and related support occupations	4	3	32	36	6	5
Sales occupations	12	12	31	37	3	4
Sales representative, finance and business services			54	60	7	6
Sales representative, mining, manufacturing, and wholesale			48	54	4	5
Sales worker, retail and personal services			17	20	2	3
Administrative support occupations, including clerical	16	14	16	17	–	–
Private household occupations	1	1	9	7	2	2
Service workers, except private household	13	13	9	11	–	–
Protective service occupations			14	21	–	–
Firefighting and fire prevention occupations			13	23	1	2
Police and detective			15	24	–	–
Farming, forestry, and fishing occupations	3	3	7	9	–	–
Farm operator and manager			13	21	–	–
Precision production, craft, and repair occupations	11	11	6	7	–	–
Mechanic and repairer			5	8	–	–
Construction trades			5	5	–	–
Machine operators, assemblers, and inspectors	6	5	4	4	–	–
Transportation and material moving occupations	4	4	4	5	–	–
Handlers, equipment cleaners, helpers, and laborers	4	4	3	5	–	–

[1] Includes workers of all ages and all levels of educational attainment. Data are provided only for major occupational groups (in bold).

– = less than 2 percent of workers have a degree

communication skills. And because many cost-conscious employers have limited the amount of training they offer, they prefer to hire more-educated workers who can assume greater responsibility sooner. As a result, college graduates are increasingly employers' first choice.

Table 3 shows the change in the proportion of 25- to 34-year-old college graduates within major occupational groups and selected detailed occupations that either experienced significant educational upgrading between 1992 and 2000 or are key occupations in the group. Percentages may be slightly underestimated, particularly with respect to the proportion of workers with an advanced degree, because although only 11 percent of undergraduates are over 35 years old, 33 percent of people attending graduate school are over age 35. Data do not indicate whether students are seeking a degree or are taking courses but are not in a degree program.

The proportion of 25- to 34-year-old workers with a college degree increased for all major occupational groups except private household workers. In addition, the three major occupational groups with the largest proportions of young college graduates—executive, administrative, and managerial; professional specialty; and sales—also had the greatest proportional growth in employment between 1992 and 2000. The sharpest increases in educational upgrading, however, were in other categories, such as farm operators and managers and protective service occupations.

As Table 3 also shows, the proportion of 25- to 34-year-olds with an advanced degree also increased from 1992 to 2000, particularly among health assessment and treating occupations—in fact, the 20 percentage-point increase in advanced-degree attainment for therapists is the largest of all the occupations in the table.

Conclusions and further study

As this article has discussed, college graduates' rising wages and growing numbers of available jobs are evidence of their demand in the workforce. How might labor markets react to this increasing demand? One possibility is that real wages for college graduates may continue to increase over the next decade. As compensation for those with a college degree continues to rise, more high school students might choose to go to college, and college graduates might select careers in which wages are increasing the fastest.

Also, depending on earnings in other occupations, college graduates working in jobs that generally are not filled by college graduates might transfer into higher paying occupations that are college preferred. Employers might also adjust their hiring strategies, with some deciding to hire—and provide training to—workers whose highest level of educational attainment is less than a bachelor's degree.

It is important to remember that individual job prospects depend on openings in a specific occupation—not on the overall number of jobs available to all college graduates. Projections vary by occupation, and this article presents information about job openings and earnings for a number of specific occupations employing significant numbers of college graduates.

To learn more about occupations that are college preferred or that require a college degree, visit your local library or career counselor's office. Among the references to look for is the *Occupational Outlook Handbook, 2002-03 Edition* (BLS Bulletin 2540), which includes training requirements as part of the description for hundreds of occupations. The *Handbook* is also available online at **www.bls.gov/oco/home.htm**.

Another way to learn about occupations is to attend job fairs and arrange informational interviews. Job fairs showcase employers seeking qualified job candidates, often those who have a college degree; informational interviews allow jobseekers to learn about specific occupations by interviewing workers in those occupations. Both subjects are explored in recent *Occupational Outlook Quarterly* articles: job fairs as part of "Employment interviewing: Seizing the opportunity and the job" (Summer 2000) and informational interviews in "Informational interviewing: Get the inside scoop on careers" (Spring 2002). Other *Quarterly* articles of interest to college students and graduates range from résumés and cover letters (Summer 1999) to distance learning (Summer 2001). Many of these articles are available as reprints or online at **www.bls.gov/opub/ooq/ooqhome.htm**.

In addition to the *Handbook* and the *Quarterly*, BLS has other career-related resources. For career information from an industry perspective, see the *Career Guide to Industries, 2002-03 Edition* (BLS Bulletin 2541), also available online at **www.bls.gov/oco/cg/home.htm**. The November 2001 issue of the *Monthly Labor Review* is devoted to the Bureau's 2000-10 projections of the U.S. economy, labor force, industry employment, and occupational employment. The *Review* is accessible online at **www.bls.gov/opub/mlr/mlrhome.htm**.

Finally, to explore employment, earnings, and other BLS data, visit its Web site at **www.bls.gov**.


EVOLVING
NEW
EMERGING

NEW AND EMERGING OCCUPATIONS

by Olivia Crosby

Something old, something new, something better... perhaps something for you. Here's how new occupations develop.

What's the next hot career field? Are fuel cell technicians and chief privacy officers here to stay? Which unusual jobs are ready for a growth spurt?

People ask questions like these hoping to learn about an entirely new occupation or some small, overlooked career that is poised for a breakthrough. And it's no wonder they ask.

In the not too distant past, many of the jobs we now take for granted didn't exist. But as technology developed, so did the need for workers who could build and use it—and sometimes, the tasks those workers performed were so different that they became part of new occupations.

Technology is only one cause of new occupations. Demographic trends—such as increased immigration, aging, and higher levels of education—also cause new types of jobs to emerge, as do business trends and shifts in consumer needs and tastes.

Workers who join an occupation at its start often are rewarded with exciting work, high earnings, and the chance to shape a profession.

But recognizing the difference between a passing fad and a stable career can be tricky, and the Bureau of Labor Statistics (BLS) makes no projections in that regard. Read on to learn how new and emerging occupations develop, why they are hard to identify, what risks and rewards vanguard workers face, and how to find a cutting-edge job. A box starting on page 19 describes some of the strategies researchers use to uncover new and emerging careers, along with some of their results. Scattered throughout are descriptions of fledgling occupations and specialties.

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Seeds of change: How occupations emerge

New occupations develop when employers need workers to do tasks that have never been done before—managing Web sites in the early 1990s, for example. Usually, workers in existing occupations add these new tasks to their jobs, sometimes creating a specialty. But if the needed task is sufficiently different and becomes the primary job of enough workers, the specialty grows to be an occupation in its own right.

Computer security is one emerging specialty. In most companies, the same workers who set up and administer computer networks also keep them secure. But as security tasks become more numerous and complex, computer workers have begun to specialize, even earning specific credentials and degrees.

Similarly, when scientists began decoding the human genome in 1990, they collected staggering amounts of biochemical data. To organize these data, employers turned to computer experts or to biologists who had some computer knowledge. But as demand increased, the field of bioinformatics grew from a small sideline to an established career. Bioinformatics specialist is now a common job title, and several schools offer specific training for these jobs.

Some of the factors that cause new specialties and occupations to emerge include changing technology, laws, demographics, and business practices. The more dramatic the changes, the more likely they are to cause occupational change.

When videoconferencing became widespread, for example, a few organizations needed workers who could set up, troubleshoot, and track the new technology full time. The resulting occupation was called videoconferencing technician.

Some other technological changes driving new specialties and occupations include:

- Improved computer graphics that have brought forth new multimedia and animation specialties;
- Increasingly sophisticated manufacturing automation and robotics that have led to new types of silicon and biological chipmaking technicians;
- New medical imaging techniques that have given rise to radiological specialties such as dosimeters, who measure bone density; and
- Improvements in data management and networking capabilities that have led to geographic information systems (GIS) technicians and

programmers, who manage data from global positioning satellites; data security engineers and analysts, who develop policies and computer programs to keep data confidential; and usability specialists, who make Web sites, software, and databases easier to navigate.

Occupations and specialties also emerge because of changes in the law. Welfare-to-work legislation, for example, prompted the need for new types of job coaches and human services workers. Telecommunications laws that require closed captioning of television programs have spurred growth of closed captioners, or stenocaptioners—workers who type captions for television programs. And changes in criminal laws have led to occupations such as restitution specialists and victim's, witness, and children's advocates.

New occupations develop when employers need workers to do tasks that have never been done before.

Likewise, changes in Medicaid regulations created a demand for new types of record keepers and record makers—including assessment specialists, who test the mental and physical functioning of residents in assisted-living institutions and report their findings to government agencies.

Demographic shifts and social developments are another source of new occupations and specialties. To serve an aging population, organizations began employing workers with expertise in geriatrics, including geriatric nurses, human services workers, and social workers. An increase in the demand for plastic surgery has resulted in the need for medical aestheticians, who combine skin-care proficiency with medical knowledge to care for patients' skin after surgery.

And increases in the number of two-income households have spurred new service occupations, such as personal chef and corporate concierge. (To learn more about the latter occupation, see "You're a *what*? Corporate concierge" in the Spring 2002 *OOQ*, available online at **www.bls.gov/opub/ooq/2002/spring/yawhat.htm**.)

New occupations and specialties also result from changes in business practices. The increase in the use of health management organizations, for example, drove demand for utilization review coordinators and restorative therapy coordinators, both of whom examine patient records to ensure that treatment was in line with an organization's standards. Also, as more people send personal information over the Internet, a few companies are hiring privacy officers to set and enforce policies about customer and employee confidentiality.

Most new types of work result from a combination of factors. Distance learning occupations fall into this category. Improved computer networking, social trends toward lifelong education, and competition between

learning institutions combined to give rise to distance learning and its occupations. These occupations include information architects, who make sure that course organization is conducive to learning and that the Web site is simple to navigate, and course editors, who modify traditional classes for the Internet; editors reformat course content by organizing it into understandable pieces and adding multimedia and other data sources.

Fuzzy measurements: Smudges on the crystal ball

Possible causes for new occupations are easy to identify. But predicting and measuring new occupations is more difficult. For starters, it is hard to determine if technological, demographic, or other changes will lead to new occupations. Recently, experts have touted new discoveries that allow materials to be constructed one atom at a time. Some say this "nano-manufacturing" could revolutionize how products are developed. But whether this will lead to a new type of production or occupation is unknown. Even if this technology becomes widely used—which, as is the case for nearly any innovation, is uncertain—it might not create new types of work. It might simply add a few new tasks to old occupations.

In many instances, a successful technological breakthrough does not affect the working world. For example, one of the latest medical imaging techniques, the virtual colonoscopy, may have a dramatically positive effect for patients—but its adoption in the marketplace will not add to the number of occupations. The procedure is almost identical to a CAT scan, so the radiologists who perform it need little additional training.

And earlier this decade, wireless technicians were predicted to evolve into a distinct occupation of workers who would install wireless base towers and repair wireless equipment. But wireless tower installation is similar to the installation of other types of communication towers, such as those

WHAT THE RESEARCHERS SAY

Researchers for the Federal Government, State governments, educational organizations, and trade associations have studied new and emerging occupations. The methods they used for identifying these occupations include reading trade journals and job ads, interviewing employers, and conducting surveys.

Every researcher must decide whether an occupation is new enough and different enough for inclusion in a study. Following are examples of some new, emerging, and evolving occupations identified by researchers in the Federal Government, the States of Texas and Minnesota, and the National Council for Workforce Education. The researchers' methods are also described.

Federal Government studies

Two nationwide surveys by the Federal Government—the Bureau of Labor Statistics' (BLS) Occupational Employment Statistics survey and the Census Bureau's decennial census—offer some information about new occupations.

BLS survey. The Occupational Employment Statistics survey provides employers with a list of occupations common in their industry and asks employers how many of their workers are in those occupations. On a supplemental sheet, employers are asked to list and describe any other occupations in their establishments, giving particular attention to occupations that are numerically important or emerging due to technology. BLS analysts study these forms to identify recurring responses.

Some occupational titles selected by Occupational Employment Survey analysts from the 1993, 1996, and 1999 survey supplements include:

- Bereavement counselor
- Quality assurance director
- Utilization review coordinator
- Volunteer coordinator
- Webmaster.

Census. The Census Bureau's decennial census is another source of new occupational titles, although it does not include job descriptions as the BLS survey does.

Between censuses, new alternative titles are gathered for census occupations. Titles are added to the census database at the request of experts or because coders reading and recording census forms bring titles to their managers' attention. Only a few of the many new titles that occur are added. Still, looking at the titles added offers clues about occupations not currently classified. Some of the titles added between 1990 and 2000 include:

- Artificial intelligence specialist
- Employee wellness coordinator
- Ethics officer
- Human factors engineer
- Information technology (IT) specialist.

Only two titles were added to the list for the "all other computer specialists" occupational group between the 1990 and 2000 censuses: IT specialist and artificial intelligence specialist. This suggests that coders from the Census Bureau try to fit responses into existing occupations whenever possible.

Texas study

The Texas Career Development Resources office studies emerging and evolving occupations in that State. It concentrates on information technology, biotechnology, health care, and education and training. The office chose these areas because of their high wages and fast employment growth and their high level of computer and equipment use.

For each industry, analysts read trade publications, job postings, and job titles from the State's database of graduates from local schools. Analysts also interview major employers.

Emerging occupations. The study defines emerging occupations as those not identified in the 1980 Standard

Continued on page 21

used for satellite and cable television. This example illustrates that although the title of an occupation may change, the basic tasks often remain much the same.

New, emerging, or evolving? Rather than trying to predict whether changes in technology and other factors will create new occupations, most labor market researchers attempt to identify occupations that already exist and are only relatively new. Even this is

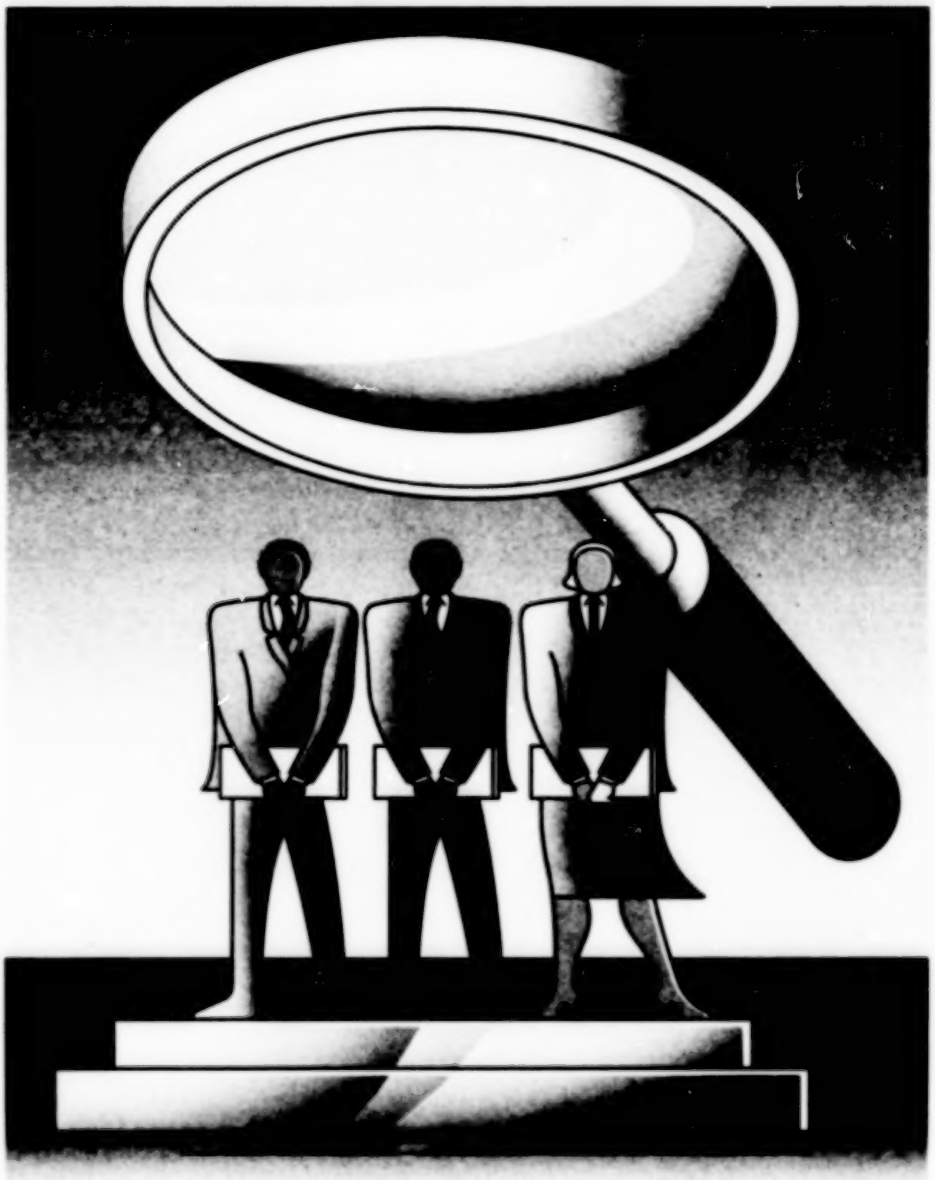
It is hard to determine if technological, demographic, or other changes will lead to new occupations.

difficult, however, in part because of unclear definitions.

For these researchers, a new occupation is one that has materialized recently—but how "recently" is defined depends on the study. A new occupation usually is identified as one that is not included in the most current occupational classification system.

An emerging occupation is one that has small employment numbers but is expected to get larger in the future. Emerging occupations are easier to identify than are new occupations because researchers usually do not notice an occupation until it has grown to a certain size. That can take years. Massage therapists, for example, created a professional association in the 1940s. Decades later, massage therapist was identified as an emerging occupation. And in 2000, it received an explicit title in the revised Standard Occupational Classification system (SOC), the Federal Government's primary catalog of occupations.

An evolving occupation is an existing occupation with tasks that are changing significantly. To some extent, all occupations are changing. But evolving occupations are changing dramatically. Examples of evolving occupations include animators shifting from two-dimensional pen-and-paper work to



three-dimensional computer modeling, software engineers learning to program artificial intelligence routines, and warehouse managers using real-time inventory practices and electronic tracking.

Specialty or occupation? Before they can decide whether an occupation is new, emerging, or evolving, researchers must decide on the meaning of the term "occupation." In general, an occupation is a set of jobs that include similar tasks and require similar skills. But how similar do the tasks of an occupation have to be? When is a job in an occupation of its own and when is it a specialty in an old one?

The work of geriatric social workers illustrates the difficulty of deciding whether tasks are unique enough to make a new occupation. Within the broad occupational group of social worker are a few well-established detailed occupations, including mental health social worker and medical and public health social worker. Geriatric social workers combine some of the tasks of both of these occupations, providing counseling, referral services, case management, and help to older patients with chronic medical problems. Does that mean geriatric social workers'

Continued from page 19

tasks are unique enough to make it a separate occupation? Or are these workers part of an existing occupation? The answer depends on the researcher.

Researchers classifying occupations must decide not only how distinct job duties must be, but also which duties are important. If core tasks are the same for a group of jobs, the jobs are in the same occupation—even if less important tasks are different. Trying to classify geographic information systems (GIS) specialists, for example, brings this issue to the fore. GIS specialist is a common title in job postings and often appears in lists of new and emerging occupations. But job descriptions suggest that these positions may be part of a number of existing occupations. Many GIS specialists maintain or program databases of geographic information, so they might be computer programmers or database administrators. Other specialists concentrate on creating maps and charts, acting as mapping technicians. Still others use GIS while planning cities, designing marketing campaigns, or conducting geographic research, possibly making them urban planners, market researchers, or geographers. However, if workers perform several of these tasks in one job, or if working with GIS is their most important task, then perhaps GIS specialist is its own occupation.

Differences in education and earnings sometimes indicate that what appears to be one occupation is actually more than one. The previously mentioned bioinformatics specialists, for example, design ways to collect and analyze biological data, usually for biotechnology firms that are seeking new treatments, genes, and proteins. Their data management tasks might make bioinformatic specialists a type of database programmer, but bioinformatic specialists' education suggests they might be a unique occupation. According to industry sources, most have advanced degrees in chemistry, biology, or a health profession, and they use that education in their work. Bioinformatic specialists' earnings, too, tend to be

Occupational Classification System (SOC). Examples include:

- Direct broadcast satellite services technician
- Internet development specialist
- Multimedia specialist
- Videoserver technician
- Wireless communications technician.

Evolving occupations. As defined in the Texas study, evolving occupations were in the SOC, but their duties had changed significantly. Among the more than 45 evolving occupations were:

- Automation or robotics technician
- Biomedical engineering technician
- Computer security technician
- Fiber optics technician
- Warehouse manager.

Minnesota study

The Minnesota Workforce Center surveyed new and emerging occupations in 1998. The Center mailed surveys to employers. Then, analysts checked and compiled responses. As with researchers in the Texas study, researchers in the Minnesota study used the 1980 SOC to determine whether occupations were new.

New occupations. New occupations were defined as occupations with "work activities, skills, and knowledge that are so new that they cannot be classified under the existing system." Some of the occupations were:

- Curriculum integration specialist
- Geographic information system specialist
- Interactive specialist
- Resident assessment specialist
- Restorative justice specialist.

Evolving occupations. Defined as "established occupations with a rapid change in skill set requiring new knowledge," evolving occupations identified include:

- Data security engineer
- Grants specialist
- Quality assurance manager, health
- Safety director
- Utilization manager.

Other studies

Education planners try to identify new occupations to establish new vocational training programs. They seek well-established occupations that are relatively new. In particular, educators usually look for occupations that have materialized in the last 10 years, require specialized training, and show a growing demand.

National Council for Workforce Education study. The latest study to identify these types of new occupations was published in 1999 by the National Council for Occupational Education, now known as the National Council for Workforce Education. To conduct the study, researchers first surveyed community colleges about vocational programs they had added in the past 2 years and programs they planned to add in the next 2 years. The researchers then studied changes in classification systems and lists of new and emerging occupations developed by a variety of sources. Next, they scanned national and local job postings.

Using this information, researchers developed their own inventory of possible training programs. The survey of new vocational programs completed for this study could help identify new occupations. A few of the reported programs include:

- Bereavement counseling
- Computer information systems
- Geriatrics
- Teleconferencing
- Web design and multimedia.

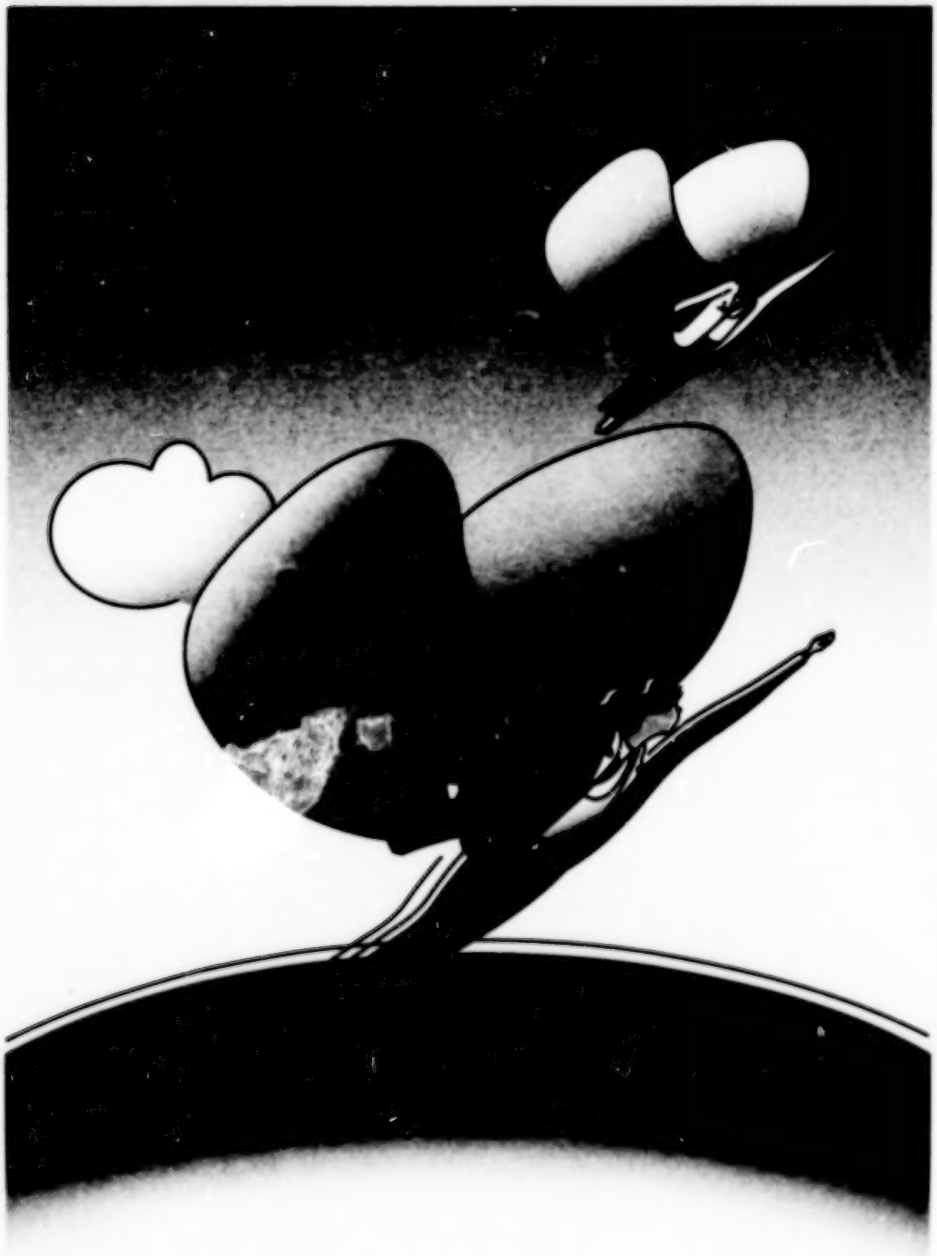
Other studies. Other education planner studies have used projections developed by BLS. One definition for an emerging occupation is a small occupation that is expected to become large. Using BLS projections, researchers can find occupations that meet this definition. Those interested in identifying emerging occupations could select occupations that in 2000 had fewer than 50,000 workers and are also expected to grow twice as fast as the average for all occupations over

Continued on page 23

higher than those of typical database programmers, according to industry sources, suggesting that their work is different.

Usability specialists are another example. These workers design and test Web sites to make them easy for visitors to navigate. Many have studied cognitive science, psychology, or human factors engineering—specialized training signaling that their work is different from that of Web designers and programmers. (For more information about this occupation, see "You're a *what*? Usability engineer" in the Winter 2000 *OOQ*, available online at **www.bls.gov/opub/ooq/2000/winter/yawhat.pdf**.)

New types of work are sometimes more accurately considered specialties of existing occupations rather than new occupations. Consider fiber optics engineers, who develop telecommunications cable and equipment, and radio frequency engineers, who plan cell-phone networks and design related equipment. These workers share most of their tasks with electrical engineers, and the most common training is an electrical engineering degree. Both fiber optics engineers and radio frequency engineers are, therefore, usually considered electrical engineering specialties rather than distinct occupations.



How many jobs? Even if composing a clearly defined list of new occupations were possible, researchers could not predict how fast each occupation would grow. One reason is that historical data on employment are not available for these occupations, so trends cannot be identified. Also, the changes that are creating a new occupation are new; little is known about them and their effects. For these and other reasons, BLS and most other researchers make no predictions about a new occupation's job growth.

Because accurate measurements are impossible, it is important not to rely too heavily on predictions about new occupations or particular job titles. Instead, jobseekers should use research about new occupations to find general trends or as a starting point for their own, more concrete investigations into the job market.

Although the title of an occupation may change, the tasks often remain much the same.

Risks and rewards of trailblazing

Building a career in a new career field can be perilous because the stability of a new occupation is hard to predict. But for workers who don't mind uncertainty, a new occupation offers unique advantages.

By their nature, new and emerging occupations are small, so they offer few opportunities for jobseekers. And most new occupations never grow large. Horticulture therapy aid, for example, was identified in 1976 as emerging. More than 25 years later, it was still small enough to be listed again as new and emerging in popular literature.

Furthermore, new and emerging

Continued from page 21

occupations are concentrated in industries that are not well established, ones in which jobs and companies can disappear quickly. "In a new industry," says Alexa Graf, a public relations worker at a cellular communications company, "you have to be ready for uncertainty. Business can fluctuate with demand and restructuring, and you have to ride it out."

The specialized nature of some new occupations also makes them less secure than others. If occupations center on a new technology, they can become obsolete as other workers learn to use that technology and integrate it into their existing occupations. Internet research technicians, for example, cited as a new occupation in a 1998 Minnesota study, face shrinking opportunities as more workers become adept at conducting their own online searches.

New occupations can be fleeting for other reasons, too. If organizations have functioned without an occupation for many years, they may decide they can do without it when budgets tighten. Examples of occupations that are often considered expendable include employee morale officers, directors of fun, and employee wellness coordinators. To reduce the risks, experts suggest learning skills that are useful in many different occupations.

Despite the difficulties, several benefits await those who find work in new and emerging occupations. Workers in new fields often are able to take advantage of labor shortages before other workers get training. Chuck Becker, a recruiting director at a geographic data company, knows about these shortages first hand. Describing the need for chief geographic information officers and project managers, Becker says, "We really need someone with many years of experience working with complex projects. That's hard to find because the field is so new." Shortages like these can lead to high earnings and good advancement opportunities for those working in the occupation before it becomes well known.

And the occupations are often exciting, offering opportunities to do what few people have done before. "Working in a field that is not established is exhilarating," says Helen Par, an editor of distance learning classes at Columbia University in New York. "I'm learning something new every day as new technology and capabilities come."

Also satisfying is the chance to direct the occupation's development. That opportunity is part of what drew Raymond Luce to his job as a fuel cell technician at an automaker's test track in San Francisco, California. "I'd never heard of this occupation before I read about it in the newspaper," he says. "And now I am at the forefront of the industry, helping to make the future."

Finding work on the new frontier

When looking for a new occupation, don't be afraid to stray from careers already identified. At best, lists of potentially new and emerging occupations provide fresh ideas and spark the imagination. You may be the first to discover a certain type of job, or you might create a unique blend of tasks for yourself. As in any job search, the key to finding a satisfying new or emerging occupation is to choose a field that interests you.

Conclusions

Several occupations were identified by multiple studies, although their status as new, emerging, or evolving varied according to the criteria used. Occupations that deal with geographic information were uncovered by the BLS, Texas, and Minnesota studies. Each cited geographic information systems specialists, who program and use information databases. The Texas study also identified geographic positioning system specialists, who install and maintain the equipment that gathers the data from satellites.

Internet occupations, too, were common among the studies. The BLS, Texas, and Minnesota studies each identified Web masters and various types of Internet specialists. The Texas study cited separate occupations, including those who create sales Web sites, those who program the "back end" of the sites, and those who conduct research over the Internet.

The 2000-10 projections decade. About 21 occupations meet these criteria. Although some are relatively novel, most are not new. Examples are:

- Biomedical engineer
- Computer and information scientist, research
- Desktop publisher
- Massage therapist
- Occupational therapy aide.

The Minnesota study identified interactive specialists, who make sites and software easier to navigate.

Business occupations were also frequently among the results. The BLS and Minnesota studies each mention quality assurance managers; International Standards Organization compliance managers, who make sure parts and products comply with established guidelines; and utilization review coordinators, who ensure that healthcare practices conform with hospital and health management organization standards.

Both the BLS and Minnesota studies identified occupations exclusive to nonprofits, such as director of development. This might reflect an increase in the use of these occupational titles, but it might also be because the SOC did not explicitly list those titles.

There is some evidence that vocational training keeps pace with new occupations. The National Council for Workforce Education survey showed that instructional courses exist for nearly every occupation cited.

To read the complete results of these studies and a more detailed explanation of their methods, see the "Explore further" section at the end of this article.

The entry requirements for new occupations and specialties usually are flexible. But there are ways to prepare. Most workers in new and emerging occupations pair basic skills with knowledge or experience in a subject related to the occupation.

Formal education increases the chances of breaking into a new field. Several studies suggest that employers are more likely to offer on-the-job training, including training for new specialties, to workers with diplomas, degrees, and certificates.

Following are a few common methods for finding and preparing for a new or emerging occupation.

Get a fresh specialty. Most new occupations grow out of old ones. To get his job as a fuel cell technician, Luce combined his 20 years of experience as a mechanic with an associate degree in electronics. "The work I do is different from car mechanic work," says Luce. "But many parts of it are the same." His experience as a mechanic showed his employers that he understood cars and had mechanical ability, and his electronics background convinced them that he could learn the fundamentals of fuel cell technology.

For a new specialty, employers are more likely to train people who have transferable skills. Tom Hasman, an information assurance analyst for an information technology services company, had a master's degree in political science and strong writing skills to help propel him into his current position. Like all information assurance analysts, Hasman develops strategies and polices to keep data secure and private. He also makes sure that all the procedures he develops conform to the latest Government regulations.

Hasman learned about computers and security policy primarily on the job. But he also wrote his master's thesis on information warfare. That showed employers that he understood the field. "You never know what is going to help you later on," he says. "If you study what interests you, it will probably end up relating to something you want to do."

Workers also can move into an emerging specialty by gradually adding new tasks to those of their current job. A human resources manager, for example, could take on more employee wellness tasks until most of his or her day was spent in that specialty. Working in large organizations makes it easier to transfer to an emerging specialty because there are more opportunities to concentrate on one type of work.

Differences in education and earnings indicate that what appears to be one occupation is actually more than one.

Some workers in emerging fields have taken their previously acquired skills to a different industry. Environmental engineers did this when applying engineering expertise to environmental problems, creating another specialty.

Working in some occupations also increases the likelihood of finding an innovative offshoot. These occupations include scientists, engineers, technicians, and those related to computers, healthcare, and the manufacturing of high-tech products. Because of their technological focus, these occupations change quickly.

Build your own occupation. Can't find a new or emerging occupation you like? Consider making your own. Some occupations start with the idea of one or two workers who either act as entrepreneurs, starting their own business, or convince employers to hire them for a new position they have designed for themselves. Whether these self-made careers qualify as occupations is debatable, however. Some say that a new occupation must include more than one or two jobs; others disagree.

Candy Wallace may have helped to develop her own occupation when she began cooking meals for her neighbors. Wallace loved to cook but did not want the stress and repetition of working in a restaurant kitchen. She cooked and delivered a week's worth of food to her clients after working with them to choose each day's menu. What made her work different from that of other types of chefs and caterers was the variety of her meals, the storage tasks she performed, and the personalized menu assessment she gave each client.

Not content to simply run a business, Wallace eventually founded a professional personal chef association, complete with training programs and market research. A few other chefs had had a similar idea and started another association. Now, these pioneers have thousands of fellow personal chefs and two professional associations.

Self-employment is not the only way to build an occupation or specialty. A recent graduate of the University of California parlayed his interests in recreation science, skiing, and geography into a salaried job. He asked a local ski resort if he could map ski routes and was hired as a permanent employee. The mixture of mapping and skiing tasks was a combination the company had never considered before. By convincing an employer of a new business need, this ski buff found a way to explore unfamiliar territory—both in the world of work and on the slopes.

Explore further

To learn more about novel occupations, see the *Occupational Outlook Handbook, 2002-03 Edition*. The *Handbook* includes descriptions for hundreds of occupations; several occupations, such as mediator and instructional coordinator, are relatively new and have appeared in the *Handbook* for the first time in this edition. The *Handbook* is available in many libraries and career centers and online at **www.bls.gov/oco**.

In addition, this issue of the *OOQ* includes articles on biotechnology and

information technology, two rapidly changing career fields.

Vocational training schools and community colleges are another source of information. Employers often ask schools to develop training programs for new specialties.

Some institutions focus entirely on rapidly changing career fields. The National Science Foundation supports 11 such training centers to prepare workers for new or technologically advanced occupations. Find out more by contacting:

Advanced Technological Education (ATE) Program
Division of Undergraduate Education
National Science Foundation
4201 Wilson Blvd., Suite 835
Arlington, VA 22230
(703) 292-8668
www.ehr.nsf.gov/ehr/due/awards/ate_centers.asp

Several organizations study new and emerging occupations. A few offer career guides and descriptions. The Texas Career Development office has published one general study and one study on occupations in biotechnology and continues to update its findings. To see the latest results, contact:

Texas Career Development Resources Office
9001 IH35 North, Suite 103B
Northview Business Center
Austin, TX 78753-5233
(512) 837-7484
www.cdr.state.tx.us/emerging/index.htm

In 1999, the Minnesota Department of Economic Security published a report on new and evolving occupations. For a copy of this report, contact:

Minnesota Department of Economic Security
390 N. Robert St.
Saint Paul, MN 55101
1 (888) 234-1114 (toll free)
www.mnwfc.org/lmi/neo

The State of California publishes career guides for many occupations, including several identified as new and emerging. California also conducted a focus group on new information technology occupations. To learn more about the career guides and the study, contact:

Employment Development Department
800 Capitol Mall, MIC 83
Sacramento, CA 95814
(916) 262-2162
www.calmis.cahwnet.gov/htmlfile/subject/guide.htm

The National Council for Workforce Education conducted a survey of new associate degree subjects. These might relate to new or emerging careers. For a copy of the results, request a copy of "A Model for Identifying New Occupational Markets for Community and Technical Colleges" from:

National Council for Workforce Education
1161 Francisco Rd.
Columbus, OH 43220-2654
(614) 451-3577
www.ncwe.org


JOBS
BIOT
APPLYING OLD

IN TECHNOLOGY: SCIENCES TO NEW DISCOVERIES

THESE WORKERS MAKE A CAREER OF TWEAKING MOTHER NATURE. FIND OUT WHO DOES WHAT WHERE THE CHROMOSOMES ROAM.

by Azure Reaser

You walk into the room, aware that they already know your identity. They know your face better than you do; the patterns of your fingerprints are no secret, either. Your past is an open book. There is nothing left to hide.

Sound like science fiction? Guess again: it's biotechnology, a field of science that fuses engineering and technology with the life sciences. Authentication systems, like the hypothetical one described above, are an example of biotechnology's emerging uses. They are one of many developments that have shone the spotlight on this field.

But what, exactly, is biotechnology? And, more importantly for your future career plans, what kinds of jobs are there in this field?

The answer to that first question isn't easy. Some think biotechnology refers only to the manipulation of genetic material, the use of recombinant DNA. But biotechnology processes date back thousands of years: humans learned to breed animals and produce foods, such as wine and cheese, long before they had any understanding of genetics or fermentation. Both the modern definition and the technology have expanded to cover many areas related to biology and medicine. For purposes of this article, biotechnology is broadly defined as the science of using molecular biology to create new products.

Regarding the second question, jobs related to biotechnology vary widely. Geneticists might alter the genetic codes of living organisms to create new foods or medicines. Animal research associates work with animals used for research and experiments. Assay analysts test and maintain tissue and cell cultures. These and other biotechnology-related occupations discussed on the following pages illustrate three types of work within biotechnology: medical research and development, agricultural research and development, and production. The occupational descriptions include job duties, working conditions, employment, earnings, and training requirements—from a high school diploma plus experience to a doctoral degree.

This article provides an overview of biotechnology as a career field and, consequently, does not cover every biotechnology-related occupation—such as the biometric engineers and scientists who develop authentication systems. In addition to presenting occupational descriptions, the following pages discuss nontechnical jobs within biotechnology, the pros and cons of working in this field, and resources to help you continue exploring the ever-changing world of biotechnology.

Medical research and development

Perhaps the best known area of modern biotechnology is its use in medical research and the development of pharmaceuticals and medical therapies. Biotechnology scientists and technicians working in medical research and development study the human body and the intricate way in which it functions. Occupations include geneticist, biomedical engineer, and clinical research coordinator and associate.

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Geneticist

Working in either medical or agricultural research, geneticists study genes from plants, animals, and humans to determine how genes interact with each other, evolve, and duplicate.

Developments in mapping the human genome—the set of all genes in human DNA—are taking biotechnology to a new level. Geneticists are gaining insight into ways of preventing a disease from even starting. "In the future," says Tim Lockie, director of business operations with a gene-transfer research firm in Madison, Wisconsin, "we hope that custom-tailored medicines specific to people's genetic backgrounds will be available."

Working conditions. Geneticists usually work in laboratories to study genetic material. They use both standard equipment, such as microscopes, and more advanced tools, such as DNA scanners. Some equipment is designed for gene therapy and gene manipulation procedures. Geneticits also pore over vast amounts of data with the help of computers and special software.

Often relying on grants for funding, geneticists work in industry, academia, and Federal and State governments.

Employment and earnings. In Bureau of Labor Statistics (BLS) data, geneticists are included within the larger occupation of biological scientists. Biological scientists held about 73,000 jobs in 2000, the most recent year for which data are available. Almost 25 percent of all biological scientists worked in the Federal Government, and another 22 percent worked in research and testing services.

Median annual earnings of biological scientists were $49,000 in 2000. According to a salary survey by the National Association of Colleges and Employers, starting offers for biological scientists in 2001 averaged $42,744 for doctoral degree recipients.

Workers in biotechnology are no strangers to technology. Geneticists, for example, use computers for tasks ranging from DNA mapping to data analysis.

Training. A doctoral degree is usually necessary to work as a geneticist. Geneticists usually study biology or genetics as undergraduates, but a major in one of the physical sciences with a minor in biology is acceptable for many Ph.D. programs. Doctoral programs in genetics usually involve laboratory work, research projects, and genetics-related courses.

Biomedical engineer

Biomedical engineers are behind innovations such as artificial limbs, edible sensors, and sophisticated monitors used during surgery. These workers combine biology and medicine with engineering to develop machines and processes. Using their engineering knowledge, biomedical engineers develop devices and procedures to solve medical and health-related problems and to research the biological systems of humans and animals. For example, they may design laser systems for use in corrective eye surgery or develop artificial organs, imaging systems, and devices for regulating insulin.

Specialties within biomedical engineering include biomaterials, biomechanics, medical imaging, rehabilitation, and orthopedic engineering.

Working conditions. Biomedical engineers are employed in a variety of settings, from hospitals to research facilities to industry, depending on their specialization. In hospitals, they may design equipment for patients who have severe burns or who are paralyzed, developing systems to monitor their condition. In research facilities, biomedical engineers supervise or participate in projects to develop equipment, pharmaceuticals, or cures for disease. And in industry, they may be involved in performance testing of new products or may advise companies on proper safety standards for medical machinery.

Employment and earnings. Biomedical engineers held about 7,200 jobs in 2000, according to BLS. Manufacturing industries employed 30 percent of all biomedical engineers, primarily in the medical instruments and supplies industries. Some biomedical engineers worked for health services; others worked as contractors for government agencies or as independent consultants.

Median annual earnings of biomedical engineers were $57,480 in 2000. According to the National Association of Colleges and Employers, biomedical engineers with a bachelor's degree received average starting salary offers of $47,850 per year in 2001 and those with a master's degree were offered an average of $62,600.

Training. A bachelor's degree in either biomedical engineering or a closely related specialty, such as mechanical or electronic engineering, is required for almost all entry-level biomedical engineering jobs. Students take core engineering classes first, followed by coursework in the biomedical engineering specialty. Some programs offer many different concentrations; others offer a limited number. Prospective students should investigate curricula and accreditations before selecting a program.

Biotechnology scientists and technicians in medical research and development study the human body and its functions.

Graduate training is necessary for most biomedical engineering faculty positions and many research and development programs.

Clinical research coordinator and associate

Making sure that new medicines are safe is the work of these researchers. Clinical research coordinators and associates test new drugs and medical procedures by monitoring human responses to medical treatment. Clinical research coordinators recruit and screen patients who try new treatments and monitor and report on patient progress. Clinical research associates use automated equipment to evaluate test results, ensuring that the study is conducted properly and meets regulations. They also supervise others conducting the tests and may develop the methods used in the study and prepare final reports.

Working conditions. Clinical research coordinators and associates usually work in large hospitals or independent laboratories. Depending on the type of clinical studies they perform, clinical research coordinators and associates may have to work rotating shifts that include nights, weekends, and holidays.

Employment and earnings. Although BLS does not have data on clinical research coordinators and associates, medical and clinical laboratory technologists and technicians, some of whose duties are similar to those of coordinators and associates, held 295,000 jobs in 2000. Health services employed about 86 percent of all medical and clinical laboratory technologists and technicians, with hospitals accounting for 52 percent and medical and dental laboratories accounting for another 13 percent.

Median annual earnings in 2000 were $40,510 for medical and clinical laboratory technologists and $27,540 for medical and clinical laboratory technicians. In hospitals, median

Animal research associates work primarily with animals, such as rats and mice, that are used in experiments.

earnings were $40,840 for technologists and $28,860 for technicians; in offices and clinics of medical doctors, median earnings were $38,850 and $27,180, respectively; and in medical and dental laboratories, median earnings were $39,780 and $25,250, respectively.

Training. For entry-level jobs, both clinical research coordinators and clinical research associates usually need a bachelor of science degree or training as a registered nurse. Coordinators and associates also need some clinical experience, either in medical research, nursing, or pharmaceuticals. For some jobs, coordinators may need a master's degree in science or a related clinical field. Applicant experience is a significant factor for filling senior coordinator jobs. Individuals are sometimes considered for associate positions if they have a high school diploma or an associate degree and at least 3 years of experience.

Although not required, certification is available from the Association of Clinical Research Professionals for clinical research coordinators and associates. Certification allows coordinators and associates to demonstrate that they have met eligibility requirements and have at least a minimal level of job-related knowledge and skills. Recertification is required every 2 years.

Agricultural research and development

Increasingly, biotechnology is being applied by workers in agriculture to modify and improve crops and animals. Some scientists working with plants transfer genes between dissimilar plants to produce crops that are able to resist disease or thrive in harsh environments. Scientists working with animals might develop tests and antibodies to diagnose, treat, and prevent ailments in farm animals. The occupations discussed in this section—plant breeder and animal research

associate—are involved with these facets of agricultural research and development.

Plant breeder

Plant breeders develop hybrids: they cross-breed plants that have desirable characteristics with other plants to produce plants and seeds with superior traits. Although this has been a common practice for centuries, biotechnology allows plant breeders to modify a plant's genes more precisely.

In agriculture, workers apply biotechnology to modify and improve crops and animals.

Plant breeders working in biotechnology manipulate the genetic material of some plants to incorporate genetic material from other, sometimes unrelated, organisms. For example, breeders have discovered proteins in some plants that provide natural self-protection from insects—and have successfully transferred into crop plants the genetic material producing these proteins. However, the use of genetically modified plants is controversial and is heavily regulated.

In addition to planning and conducting research, a plant breeder's responsibilities may range from public relations to advising management.

Working conditions. Plant breeders usually work in offices or laboratories, although they may do new-product trials offsite. Some travel may be required to meet with other breeders. Because they often depend on grant money to support their research, plant breeders may be under pressure to meet deadlines and to conform to rigid specifications in preparing funding proposals.

Employment and earnings. In BLS data, plant breeders are included within the occupation of agricultural and food scientists. Agricultural and food scientists held about 17,000 jobs in 2000. About 32 percent of all salaried, nonfaculty agricultural and food scientists worked for Federal, State, or local governments. Nearly two-thirds worked for the Federal Government, primarily in the U.S. Department of Agriculture. In addition, large numbers worked for State agricultural colleges or agricultural research stations. About 23 percent were self-employed, chiefly as consultants. Almost 9 percent worked in the research and testing services industry, most of them in commerical research and development laboratories. The rest were distributed throughout different industries.

Scientists and technicians in biotechnology, like those in other fields, usually perform job duties in laboratories and offices.

Median annual earnings of agricultural and food scientists were $52,160 in 2000. Average salaries for Federal workers in some agricultural science specialties in 2001 were as follows: agronomy, $62,311; soil science, $58,878; horticulture, $59,472; and entomology, $70,133.

Training. Plant breeders must have at least a bachelor's degree and 2 years of plant breeding or agronomical experience, along with training in plant breeding or plant science. Most plant breeders have a master's or doctoral degree. Breeders who develop and use biotechnical techniques for genetic manipulation usually have a Ph.D.

Animal research associate

Animal research associates work primarily with animals used in experiments. Some research associates modify the genetic makeup of laboratory animals, such as rats and mice. Others use biotechnology-based diagnostic tests on livestock herds

for early and more accurate diagnosis of disease. Current research projects include creating edible vaccines for livestock and investigating the feasibility of producing disease-resistant livestock. Animal research associates' other job duties include feeding animals and cleaning their living quarters, assessing animal health, harvesting tissues, and maintaining research documentation.

Working conditions. Animal research associates work in research facilities, private clinics, animal hospitals, and farms. Some tasks may require physical strength for lifting and moving animals. Because animals need constant care, animal research associates often work weekends, nights, and holidays. Most full-time associates work about 40 hours per week, but some work 50 or more hours per week.

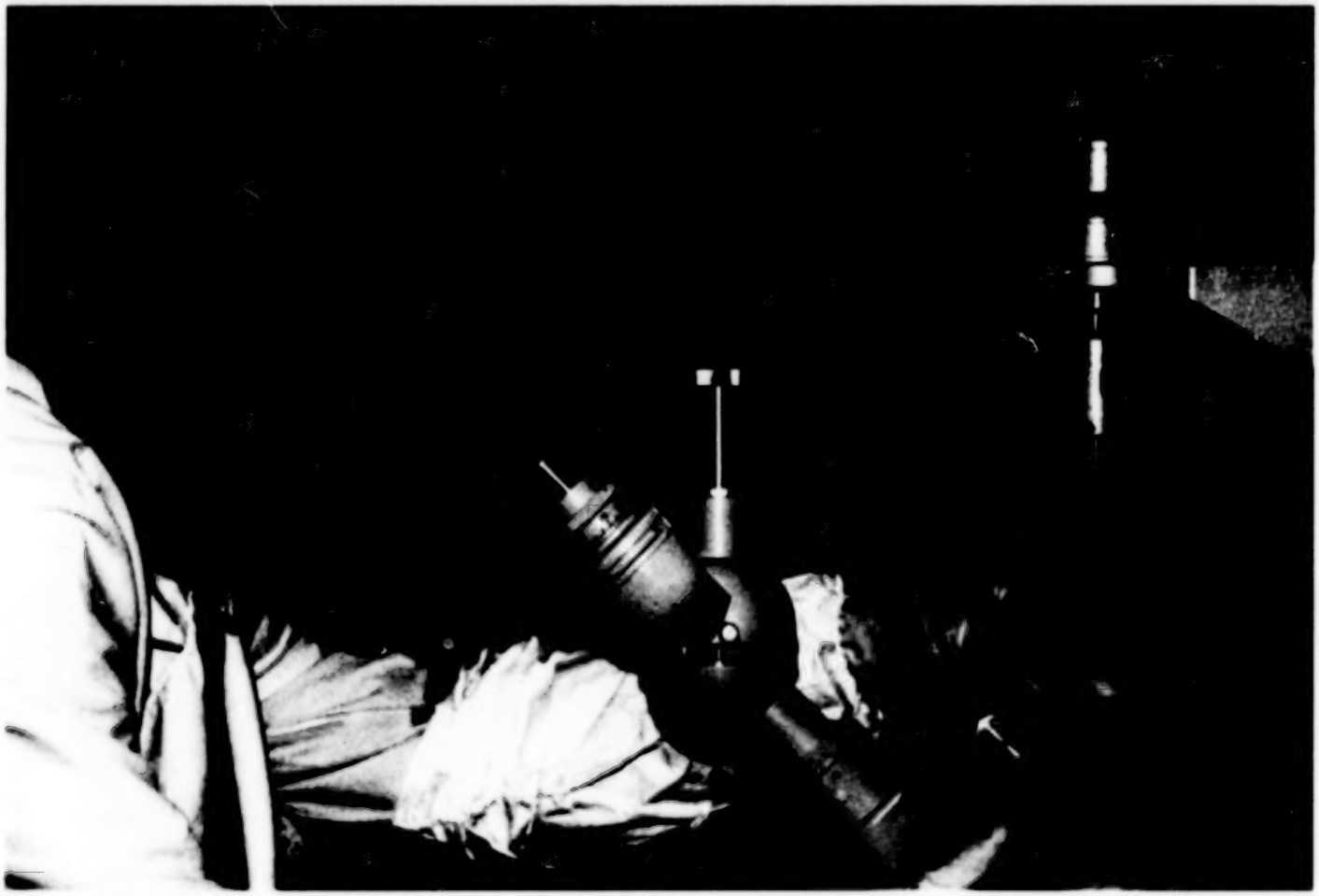
Employment and earnings. BLS does not have data on animal research associates. But BLS data show that veterinarians, who have some job responsibilities similar to those of animal research associates, held about 59,000 jobs in 2000. And according to the National Association of Colleges and Employers, beginning salary offers in 2001 for jobseekers with a bachelor's degree in animal science averaged $28,031 per year.

Veterinarians had median annual earnings of $60,910 in 2000. Veterinary medical college graduates entering the Federal Government earned at least $35,808 in 2001.

Training. Animal research associates must have a bachelor's degree in biology or a related subject. They should have 2 to 8 years of experience working with animals in a veterinary or research setting.

Production

Biotechnology production workers move the results of biotechnology research from the laboratory to the marketplace. These workers develop safe and efficient methods for mass producing biotechnology-developed products, such as



Assay analysts work with scientists and technicians, preparing slides and other equipment for tests of tissue and cell cultures.

drugs. In some ways, the jobs of these workers are similar to those of production workers in other fields. However, production workers in biotechnology, including process development associates and assay analysts, usually need additional skills and training.

Process development associate

Most of the job duties of process development associates revolve around optimizing and improving manufacturing processes. These associates develop processes that improve product yield and reduce costs in various areas, including fermentation and purification, and research and implement new methods and technologies to enhance production.

Working conditions. Most process development associates work 40 hours per week in offices or manufacturing plants but may have to work more, depending on the project they are assigned. Travel to other plants sometimes is needed to observe different production processes and to meet with management.

Employment and earnings. In BLS data, process development associates are included among industrial engineers. In 2000, industrial engineers held about 154,000 jobs, more than 75 percent of which were in manufacturing industries. But because of the diverse nature of their skills, industrial engineers were also employed in other industries, including engineering and management services and business services.

Median annual earnings of industrial engineers were $58,580 in 2000.

Training. Process development associates need a bachelor's degree in a scientific or engineering discipline and at least 2 years of experience in manufacturing. Associates working in biotechnology also benefit from training in biology, chemistry, and chemical production.

Assay analyst

Assay analysts prepare, maintain, and test tissue and cell cultures—groups of these materials growing in scientifically controlled environments. Analysts prepare required equipment and tools, which include Petri dishes and slides. In testing cell and tissue samples, they use chemicals following instructions from scientists and science technicians. Assay analysts monitor cultures' reactions and record results of their tests.

Working conditions. Most assay analysts work indoors, usually in laboratories. Although most have regular hours, some may occasionally work irregular hours to monitor experiments that cannot be completed during their regular shifts. Some technicians may be exposed to hazards from equipment, chemicals, or toxic materials.

Employment and earnings. BLS does not collect information about assay analysts, but it does have information about chemical technicians, whose work is similar. Chemical technicians held about 73,000 jobs in 2000, according to BLS. More than 68 percent of the jobs were in the manufacturing sector, specifically chemicals and allied products, where chemical technicians held more than 30,000 jobs. Research and testing services employed more than 12,000.

Chemical technicians, most of whom have a bachelor's degree, had median hourly earnings in 2000 of $17.05. Assay analysts usually make less than that amount, in part because the tasks they perform are less complicated than those of chemical technicians. Earnings for chemical technicians varied by industry: in research and testing services, earnings ranged from $8.64 for the lowest 10 percent to $20.28 for the highest 10 percent; in drug manufacturing, earnings ranged from $11.47 for the lowest 10 percent to $26.93 for the highest 10 percent.

Production workers in biotechnology develop safe methods for mass producing biotechnology-developed goods.

Training. Assay analysts need a high school diploma or equivalent. Some laboratory experience is recommended.

Biotechnology jobs for nonscientists

In addition to the many scientific jobs involving biotechnology, there are many nonscientific jobs that usually do not require training in biology. However, some science knowledge often is recommended. "There are jobs available no matter what background or education you have, because biotechnology is such a diverse field," says Nat Page, a molecular breeding coordinator with a research firm in Arlington, Wisconsin.

Jobs relating to biotechnology are diverse. Occupations include writers and editors, who describe developments in biotechnology for trade journals or other media; public relations or marketing specialists, who coordinate the flow of information to and from biotechnology companies; and genetic counselors, who work with those adversely affected by genetic disorders as well as with families who may be at risk of inheriting genetic diseases.

Nonscientific training or skills may be useful in many biotechnology jobs. For example, sales ability is important in

Meaningful, independently directed work may draw people to careers in biotechnology.

jobs that involve selling biotechnology processes or products. Knowledge of federal licensing requirements is a must when working toward getting a biotechnology product licensed. And an auditing background is helpful for ensuring that business operates effectively on a tight budget.

In addition, jobseekers in biotechnology, like job applicants in most career fields, should develop the core skills employers usually seek. These include communication and interpersonal skills and organizational ability. Other sought-after applicant traits often cited by biotechnology employers are recordkeeping skills, management ability, and willingness to travel. Jobseekers also should convey an interest in biotechnology as a career field.

Information about most nonscience biotechnology jobs is accessible through the same channels used for science ones: Internet searches, employer inquiries, and job postings. The best way to learn about qualifications for a specific job is to contact the biotechnology employer directly.

Pros and cons of biotech work

Working in biotechnology has many advantages, but, like all career fields, it also has some drawbacks.

Meaningful work is one of the most commonly cited benefits of these jobs. The products workers create improve the health and nutrition of the world's population.

Jobseekers in biotechnology should develop core skills that employers seek.

Some principal scientists also say that worker independence is one of the best aspects of their jobs. Interesting work is another plus: biotechnology workers regularly learn new techniques and make discoveries.

Biotechnology is a vast field with much potential. But because it is not a specific industry or occupation, biotechnology employment projections are not produced by BLS. Still, BLS projections for some industries involved with biotechnology—including agricultural services, drug manufacturing, and health services—give some indication of its prospects. And these industries are projected to grow faster than the average throughout the 2000-10 decade.

For example, agricultural services, which includes veterinary and animal services, is projected to grow 39 percent, more than twice the average for all industries. Drug manufacturing is projected to grow 24 percent, and health services is expected to grow 25 percent. Combined, these industries are projected to add more than 3 million new jobs to the economy between 2000 and 2010.

New jobs are not employment guarantees, however, and jobs in biotechnology may be harder to find because projects in biotechnology are subject to fluctuations in funding. And the work can be frustrating. Laboratory workers need patience because they often must repeat the same tasks and experiments many times, waiting months for a breakthrough. Even after the laboratory work is complete, many of the products biotechnology workers develop never make it to the public. Regulations and financial considerations mean that some discoveries are shelved.

On the other hand, most scientists understand these restrictions and enjoy the challenges of their work despite its limitations. As one biotechnology scientist notes, keeping up with new technologies may not be easy, but the potential rewards are worth the effort.

Other sources of information

Reading this article is a good way to start learning about careers in biotechnology. To find out more, visit your local library or your school's career counseling center. Look for resources about biotechnology, biotechnology-related occupations, or other science occupations. Among the resources available in most libraries and career centers is the *Occupational Outlook Handbook, 2002-03 Edition*, which has more than 270 occupational statements describing the nature of the work, working conditions, employment, training requirements, earnings, and outlook for about 90 percent of the jobs in the economy. The *Handbook* also is available online at **www.bls.gov/oco**.

As the occupational examples in this article illustrate, experience is part of the entry-level training requirement for many biotechnology occupations. Many biotechnology employers offer internships for high school and college students who are interested in learning more about biotechnology companies. Whether in the laboratory or in the field, job experience can help you begin a career in biotechnology.

Information is available through most State biotechnology associations. These associations usually have general facts about biotechnology as well as statewide information about jobs, education, and current events. They also may be able to assist you in making contacts by providing employer directories. For links to State organizations, contact:
National Center for Biotechnology
Bio-Link
City College of San Francisco
50 Phelan Ave., Box S-12
San Francisco, CA 94112
(415) 487-2472
www.bio-link.org

To learn more about biotechnology, contact the following organizations:
Biotechnology Industry Organization
1225 Eye St. NW., Suite 400
Washington, DC 20005
1 (800) 255-3304
(202) 962-9200
www.bio.org

Council for Biotechnology Information
P.O. Box 34380
Washington, DC 20043–0380
(202) 467-6565
www.whybiotech.com

Salaries dip for college grads—but not in all fields

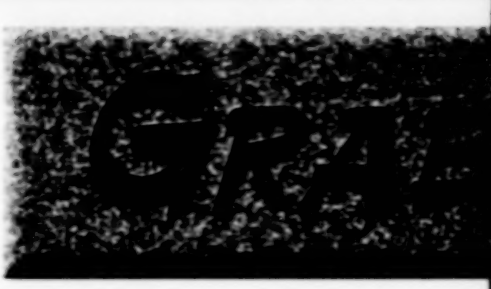
The slowing economy meant lower starting salaries for many of this year's college graduates, according to surveys by the National Association of Colleges and Employers. But salaries for bachelor's degree recipients in some majors, such as chemical engineering, have held steady. And salaries in others, such as history and performing arts, have risen. Even with decreases, 2002 starting salaries for those in several fields remain higher than they were in 2000. (See below.)

For more information about the Association's surveys, write NACE, 62 Highland Ave., Bethlehem, PA 18017; call 1 (800) 544-5272; or visit **www.jobweb.org**.

Regardless of declines in 2002 starting salaries, however, college graduates usually earn more than their non-college-educated counterparts. For more details about earnings for college graduates, see "College at work: Outlook and earnings for college graduates" elsewhere in this issue of the *OOQ*.

Selected bachelor's degree majors	*Average 2002 starting salary, September through July*	*Change from 2001 starting salary, September through July (percent)*
Accounting	$39,768	+0.9
Business administration	36,429	–5.3
Chemical engineering	51,417	–0.7
Civil engineering	41,317	+1.7
Computer engineering	51,587	–4.3
Computer science	49,596	–5.9
Electrical engineering	50,123	–3.4
English	28,488	–9.6
History	31,201	+2.7
Logistics or materials management	39,407	–9.1
Management information systems	42,705	–6.3
Nursing	38,459	+4.8
Political science	28,397	–13.4
Psychology	26,456	–12.8
Visual and performing arts	27,575	+4.5

Source: National Association of Colleges and Employers *Salary Survey Summer Edition*



Technology in special education

If you're planning to teach the disabled, you'll need to be technologically savvy. Use of assistive technology—which includes screen readers for blind students to navigate the Internet and dictating software for students unable to use their hands—has been increasing, and special education teachers help students with these devices. Currently, the availability of assistive technology varies, depending on school budgets and teacher training.

In 1997, Congress passed a law mandating that assistive technology be considered for every student who receives special education services. Last year, the Instructional Materials Accessibility Act established a national electronic file format for textbooks; this will ease the conversion of textbooks to Braille, digital, or other versions. And this year, the U.S. Department of Education is offering grants for programs that train special education teachers to use technology.

Learning to use assistive technology

Federal Government scholarships

Need cash for college? You probably already know that the Federal Government offers financial aid through the U.S. Department of Education. But there are many other sources of Federal funds, especially for students interested in working for Uncle Sam.

The best way to uncover money for school is to contact Government agencies that are related to the subject you are studying. A few examples follow:

- The National Institutes of Health Undergraduate Scholarship program offers up to $20,000 annually to low-income or disadvantaged students studying biomedical, behavioral, or health science. Recipients work for the Institutes each summer and after graduation for 1 year for each year they received money. Contact: National Institutes of Health, Office of Loan Repayment and Scholarship, 2 Center Dr., MSC 0230, Bethesda, MD 20892-0230; 1 (800) 528-7689; **ugsp.info.nih.gov/default.htm**.
- Students of veterinary science and biomedicine may apply for $5,000 undergraduate or $10,000 graduate scholarships from the U.S. Department of Agriculture. Recipients work for the Federal Government during summers while they are in school and after graduation for 1 year for each year they received aid. Contact: Saul T. Wilson, Jr. Scholarship, USDA, APHIS, Human Resources, 4700 River Rd., Unit 21, Riverdale, MD 20737-1230; 1 (800) 762-2738; **www.aphis.usda.gov/mrpbs/job_opps/stw.html**.
- The National Ocean Service offers up to $32,000 annually to graduate students—particularly women and minorities—working toward advanced degrees in oceanography, marine biology, or maritime archeology. This award, the Dr. Nancy Foster Scholarship, has no service requirement. Contact: Dr. Nancy Foster Scholarship Program, Office of Assistant Administration, 13th Floor, National Ocean Service, 1305 East-West Highway, Silver Spring, MD 20910; (301) 713-3074; **fosterscholars.noaa.gov/welcome.html**.

is only part of what special educators do. Special education teachers, whose employment BLS projects will increase faster than the average for all occupations through 2010, perform a variety of other duties tailored to their students' needs. To find out more about the occupation's job duties, training requirements, outlook, and earnings, consult the 2002-03 *Occupational Outlook Handbook*. It is available in most libraries and career counselors' offices and on the Internet; the link for special education teachers is **www.bls.gov/oco/ocos078.htm**.

More information also is available on assistive technology in special education. Research summaries from the Education Resources Information Center describe current technology and its effects on student success. For a copy of these summaries and information on training grants, call the Clearinghouse on Disabilities and Gifted Education at 1 (800) 328-0272 or visit online at **www.ericec.org**.

Work at home

Homework doesn't always end after graduation, according to statistics from a survey by BLS and the Census Bureau. In May 2001, more than 19 million people—15 percent of all workers—did some work at home at least once a week and as part of their primary job.

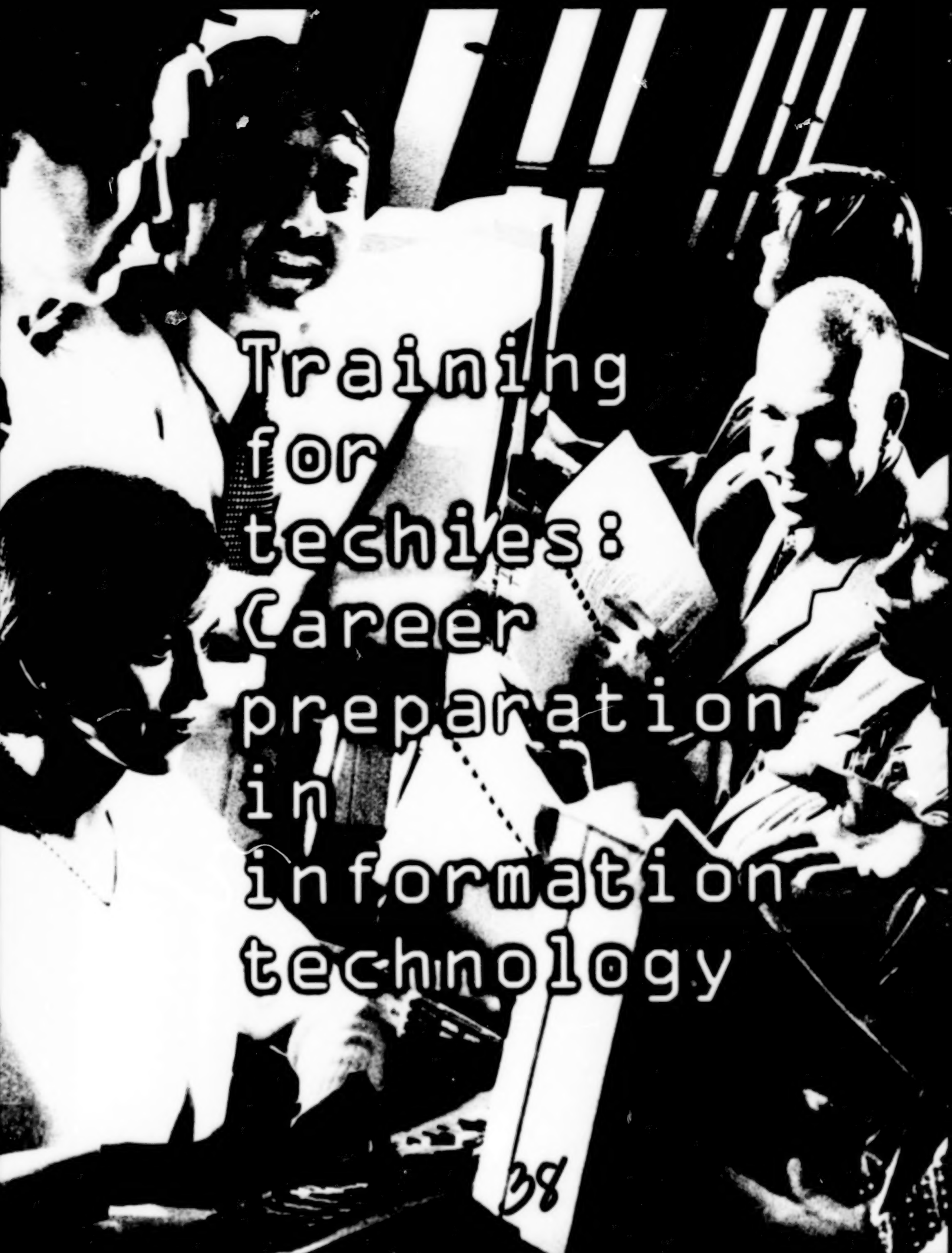
Half of these workers took work home informally, on an unpaid basis; 17 percent had formal, paid arrangements with their employers; and 30 percent were self-employed.

Of those with formal arrangements, 1 in 6, or about half a million workers, logged 35 or more hours at home.

Which occupations were the most likely to include home work? Teachers topped the list, with about 60 percent of college and university teachers and 52 percent of other teachers doing work at home. Lawyers and judges came next, with 46 percent. Sales representatives also often worked at home: about 40 percent of nonretail sales representatives and 38 percent of finance sales representatives did some work at home. Of administrative support workers, financial records processing workers were most likely to work at home, with about 14 percent doing so.

To learn more about the survey, including the demographics of home workers and reasons for working from home, call (202) 691-6378 or see an online summary at **www.bls.gov/cps**.

- Undergraduates majoring in languages, mathematics, engineering, computer science, political science, or history can apply for tuition, expenses, and a year-round salary from the National Security Agency. Recipients work for the agency during the summers and after graduation for 1½ times the length of study. Contact: NSA, Attn: Undergraduate Training Program, Office of Recruitment and Hiring, Suite 6779, 9800 Savage Rd., Fort George G. Meade, MD 20755-6779; 1 (800) 669-0703; **www.nsa.gov/programs/employ**.
- The Truman Scholarship is available to college juniors who are studying nearly any subject and who plan to attend graduate school and work in government, education, or public-service related nonprofits. Scholarship recipients get $3,000 for their final undergraduate year and $27,000 toward graduate education. Contact: Truman Scholarship Foundation, 712 Jackson Pl. NW., Washington, DC 20006; (202) 395-4831; **www.truman.gov**.
- Those planning to teach middle or high school can apply for the James Madison Memorial Fellowship, established by Congress. The fellowship offers up to $24,000 toward a master's degree in government, history, or education. Recipients teach government or history for 1 year for each year of the fellowship. Contact: James Madison Foundation, PO Box 4030, 2201 N. Dodge St., Iowa City, Iowa 52243-4030; 1 (800) 525-6928; **www.jamesmadison.com**.
- High school students who serve their communities can qualify for $1,000 Presidential Freedom Scholarships. One-half of the money comes from the Corporation for National and Community Service; the other half is gathered by the student's high school from local sources. To qualify, students must write a brief essay and must have volunteered at least 1,000 hours in the year preceding application. Contact: Presidential Freedom Scholarships, 1150 Connecticut Ave. NW., Suite 1100, Washington, DC 20036; 1 (866) 291-7700 (toll free) or (202) 742-5390; **www.nationalservice.org/scholarships**.



Training for techies: Career preparation in information technology

Preparing for careers in information technology is a function of multiple subroutines. Which algorithm will you choose?

by Roger Moncarz

Maria and Spencer are both in their early 20's. Maria recently completed her bachelor's degree in English; Spencer dropped out of college after a few semesters. If asked to speculate on Maria's and Spencer's occupations, perhaps you would guess writer and waiter.

But it might surprise you to learn that Maria is a computer systems analyst and Spencer is a computer programmer. Maria, while majoring in English, took several computer-related courses and gained experience working in a computer lab. Spencer, although not formally enrolled in a degree program, took courses at a community college and earned certification in a programming language. Both benefited from the flexible training requirements for individuals hoping to work in information technology, often identified as IT.

The Bureau of Labor Statistics (BLS) projects that 8 of the 10 fastest growing occupations between 2000 and 2010 will be computer related. For this reason, future jobseekers need to know about the variety of ways to prepare for a career in information technology. Following a discussion of how these workers are defined, this article focuses on the available training, which ranges from certificates to advanced degrees.

What is an information technology worker?

The information technology workforce is defined differently by trade organizations and Government sources.

The Information Technology Association of America defines an information technology worker by using the eight career clusters developed by the National Workforce Center for Emerging Technologies. Those career clusters include programming and software engineering, technical support, enterprise systems, database development and administration, Web development and administration, network design and administration, digital media, and technical writing. According to its latest study, "Bouncing Back: Jobs, Skills, and the Continuing Demand for IT Workers," the Association notes that 92 percent of all information technology workers are in non-information-technology companies—80 percent of them in small companies outside the information technology industry.

The U.S. Department of Commerce identifies the information technology workforce more broadly. In its report on information technology, "Digital Economy 2002," the Department defines workers in information technology occupations as those who design, manufacture, operate, maintain, and repair information technology products and provide related services across all industries.

For purposes of this article, information technology workers are considered to be those employed in 12 computer-related Standard Occupational Classification System (SOC) occupations. These occupations are:

- Computer and information systems managers
- Computer programmers
- Computer and information scientists
- Computer systems analysts

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- Computer hardware engineers
- Computer software engineers, applications
- Computer software engineers, systems software
- Computer support specialists
- Database administrators
- Network and computer systems administrators
- Network systems and data communications analysts
- All other computer specialists, a residual category of workers.

Using this definition, BLS data show that there were about 3.3 million information technology workers employed in the United States in 2000. However, that number excludes marketing and sales workers employed by information technology companies.

What type of training do I need?

As Maria's and Spencer's backgrounds suggest, there is considerable interest in the topic of education and training required for information technology workers. This interest stems from the U.S. economy's demand for such workers and a presumption that the current educational system is not producing enough of them for the workforce. Rita Caldwell, director of the National Science Foundation, notes that there are many pathways for becoming an information technology worker. Training ranges from a few months for certification to 6 years for a doctoral degree.

BLS data show that in 2001, most information technology workers—almost 70 percent—had a bachelor's or higher degree, although the number who had some college but no degree is rapidly increasing and accounted for almost 16 percent of these workers. (See chart 1.) In fact, anecdotal information

Most IT workers receive instruction through certification and degree programs.

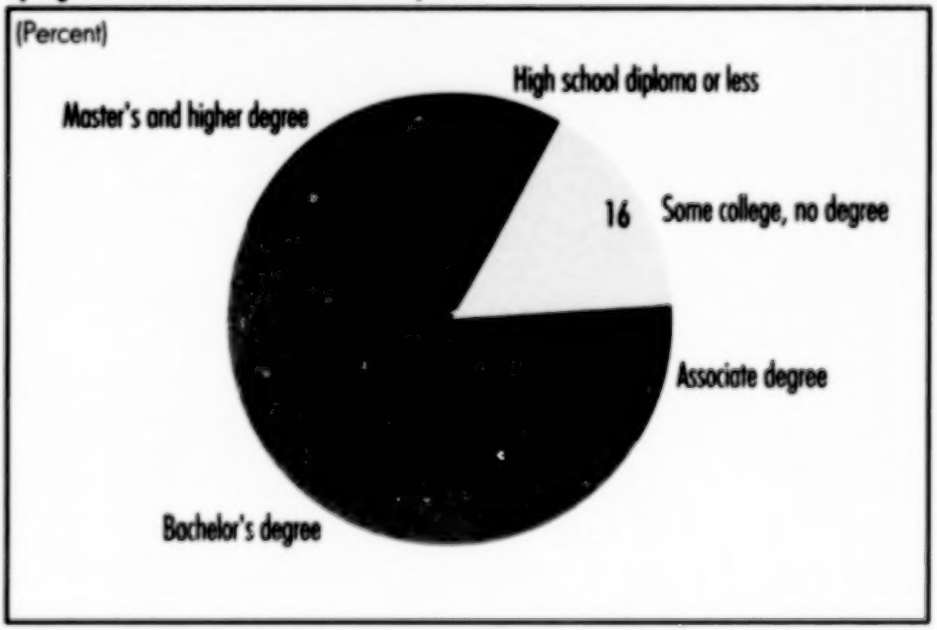
suggests that many people attend community colleges not to earn degrees but to take computer-related courses in hopes of getting a job or as a way to retrain and update their skills. And according to the National Science Foundation, two-thirds of workers who had a bachelor's degree and worked in a computer-related occupation in 1999 had majored in subjects other than computer and information sciences. (See chart 2.)

Clearly, earning a postsecondary degree in a computer-related field is not the only way to prepare for a job in information technology. But learning the technical skills necessary to work in these occupations remains paramount. Specialized certification and degree programs—associate, bachelor's, and graduate-level ones—are the primary ways workers train for information technology occupations.

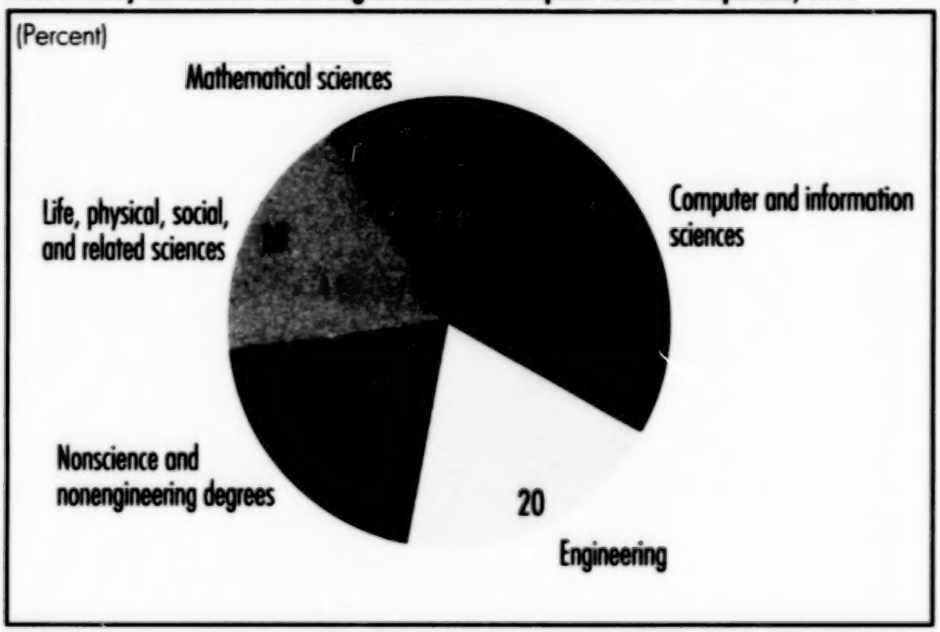
Certification

Technical or professional certification demonstrates that an individual has achieved a level of competency in a

Distribution of workers in computer-related occupations by highest level of educational attainment, 2001



Field of study distribution for all degree holders in computer-related occupations, 1999



Source: National Science Foundation. 1999 SESTAT Integrated Data System. The SESTAT Web site is sestat.nsf.gov.

particular field. There are various certificates available for information technology workers. Spencer, for example, earned certification that qualified him for a computer programming job. Product vendors and industry organizations offer different types of certificates, providing a training niche that is expected to continue.

Growth of certification. According to the Information Technology Association of America's study on the information technology workforce, the significance of certification has grown in each of its job categories in the last year. Kenneth Bartlett, project director for the National Research Center for Career and Technical Education, says that as of August, there were almost 100 vendors and organizations offering more than 670 separate certificates in information technology.

And these certificates are growing more popular. Data from the U.S. Department of Education's National Center for Education Statistics show that the number of awards of less than 1 year granted in computer and information sciences grew almost 400 percent between 1990 and 2000.

When international trends are considered, the impact of certification is even more dramatic. In his 2000 report, "The Certification System in Information Technology," author Clifford Adelman describes a "parallel universe" outside conventional educational routes for potential information technology workers to develop skills. The report notes that, by early 2000, about 1.6 million people worldwide had earned roughly 2.4 million information technology certificates.

Vendor and organization certification. Product vendors and software firms—including Microsoft, Cisco, and Oracle—offer certification and may require individuals who work with their products to be certified. And industry organizations, such as the Institute for the Certification of Computing Professionals, offer voluntary certification. The Institute's certification is available to those who have a college degree, at least 2 years of experience, and have passed a series of examinations.

Vendor certification evolved from the difficulty employers had finding skilled workers to fill the rising number of high-tech jobs created by the Internet boom in the mid- to late 1990's. Because certification is faster, cheaper, and more focused than traditional educational tracks, vendor certification soon emerged as a solution to the problem of worker shortages.

As of May, Microsoft Corporation had issued more than 1.2 million certificates to individuals classified as Microsoft Certified Professionals. One example of the rapid growth in vendor certification is the increase in the number of Microsoft Certified Systems Engineer certificates awarded over the last few years: 35,000 in fall 1997; 280,000 by June 2000; and almost 463,000 by July 2002.

Future of certification. Certification has become an increasingly important standard in the information technology industry in the last decade. However, it also has become more controversial. Although it enables workers to demonstrate a specific set of skills, some employers say that certification is not a viable substitute for practical experience. Others prefer that workers have formal education and practical experience, predicting that certificates will diminish in importance. But as the following example illustrates, certification should continue to play a role in training information technology workers.

The growing importance of network security in information technology has

led to an increased demand for computer security professionals. Someone who wants to work in information security can get one of a variety of certificates instead of a 2- or 4-year degree. Employers interested in securing their organizations' computer networks seek individuals with expertise in information security—which, presumably, a specialized certificate demonstrates.

In an era in which new technology may become obsolete in a few years, acquiring skills quickly is important to both employers and workers.

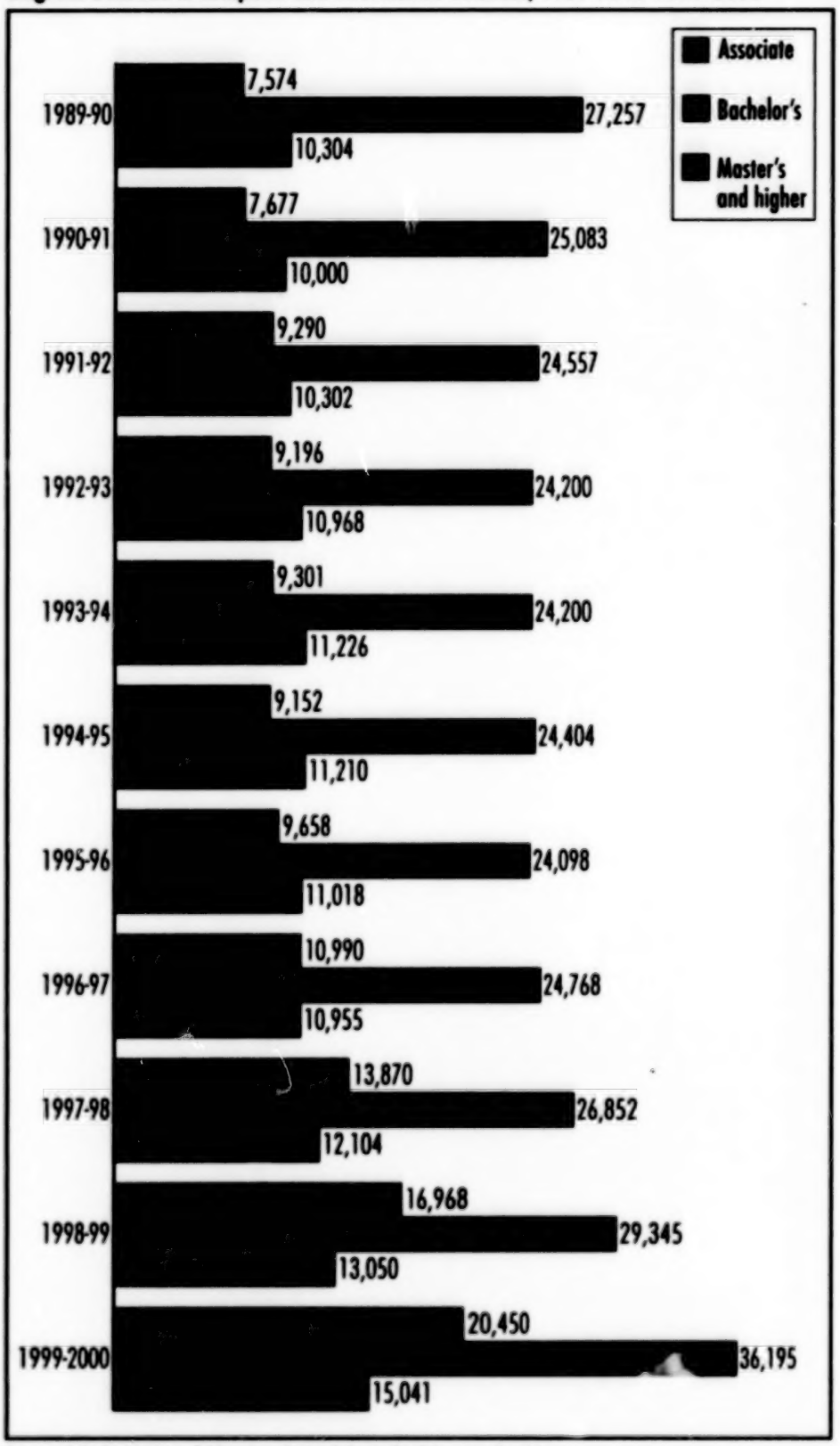
Degrees

Many employers of information technology workers require applicants to have a degree, which they perceive as proof of a worker's ability to think logically. And there are plenty of options for students interested in earning a degree in information technology. According to the National Center for Education Statistics, computer and information sciences include computer programming, data processing, information science and systems, computer systems analysis, and computer science.

But as mentioned previously, most information technology workers who have a degree do not have one in a computer field. Some, like Maria, studied subjects completely unrelated to information technology and gained computer knowledge through other coursework and related experience. Associate, bachelor's, and graduate degree programs have different focuses in training workers for information technology jobs.

Associate degrees. The associate degree is an increasingly attractive option for information technology workers. Most community colleges and many independent technical institutes and proprietary schools offer an associate

Degrees awarded in computer and information sciences, 1989-90 to 1999-2000



Source: U.S. Department of Education, National Center for Education Statistics

degree in computer science or related information technology fields. Because many of these programs are designed to meet the needs of local businesses, they are more occupation-specific than are those of a 4-year degree. Some jobs may be better suited to the level of training these programs offer. Many students who earn an associate degree seek employment as computer support specialists or as computer programmers.

There has been a steady rise in the number of associate degrees granted in the computer and information sciences over the last decade, from fewer than 8,000 in 1990 to more than 20,000 in 2000. (See chart 3.) Furthermore, the number of associate degrees conferred in the business information and data processing services doubled from about 7,000 in 1991 to nearly 14,000 in 2000.

Bachelor's degrees. As previously indicated, most information technology workers have at least a bachelor's degree. In his report for the National Research Center for Career and Technical Education, "The Perceived Influence of Industry-Sponsored Credentials," Kenneth Bartlett points out that employers still prefer a 4-year college degree as preparation for information technology jobs. And in a tight job market, preference for a bachelor's degree rises as employers attempt to differentiate among potential jobseekers. But the degree concentration and relevant experience required may vary by occupation.

For computer software engineers, most employers prefer that applicants have at least a bachelor's degree and broad knowledge and experience with computer systems and technologies. The usual degree concentrations for applications software engineers are computer science and software engineering; for systems software engineers, usual concentrations are computer science and computer information systems.

There is no universally accepted way to prepare for a job as a systems analyst or database administrator, network administrator, or network systems and data communications analyst. However, most employers place a premium on some formal college education; a bachelor's degree is a prerequisite for many jobs. Some workers in these occupations have a degree in either computer science, mathematics, or information systems.

The number of bachelor's degrees awarded in computer science rose between 1990 and 2000. However, an increasing number of people in the information technology workforce had a non-computer-related degree. Chart 4 shows that for bachelor's degree holders in computer-related occupations in 1999, more than half the workers had studied something other than the computer and information sciences. Large numbers of workers did have degrees in related fields, such as engineering and math. According to the National Center for Education Statistics, for example, the number of bachelor's degrees conferred in management information systems rose dramatically: from 4,700 in 1991 to almost 15,000 in 2000.

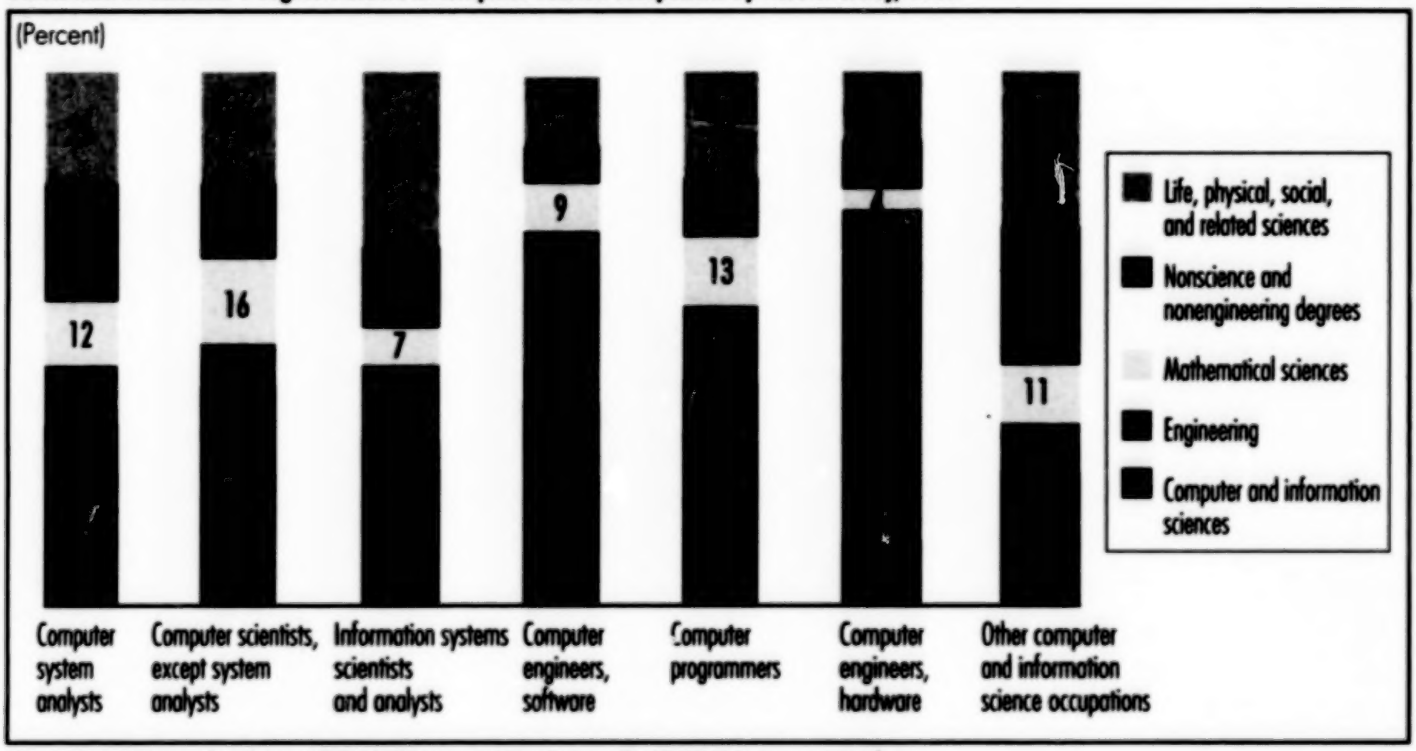
Acquiring IT skills quickly is important to employers and workers.

The lack of emphasis on computer-related bachelor's degrees in information technology occupations points up an important trend for prospective information technology workers. Employers still demand technical skills, but "soft" skills—including the ability to communicate effectively, both orally and in writing—also are important for these jobseekers to have. Knowing how to write a computer program or administer a database is critical, but ability to interact with other computer specialists, clients, customers, and users continues to gain importance.

The need for multidimensional workers in information technology means that employers prefer workers who have business skills and acumen, along with relevant and up-to-date technical expertise. Thus, it is not surprising that increasing numbers of information technology workers do not have computer-related degrees. National Science Foundation data illustrate this point: in 1995, roughly 18 percent of computer scientists either had a nonscience or nonengineering degree or had a degree in the life, physical, social, and related sciences. But by 1999, the number of computer scientists with a degree in those concentrations had nearly doubled, growing to 35 percent.

Graduate degrees. Graduate degrees are preferred for some of the more complex jobs in software engineering and database administration. According to the National Center for Education Statistics, the number of master's degrees conferred in computer and information sciences rose sharply between 1990 and 2000, while the number of doctoral degrees in computer science grew slightly.

Distribution of bachelor's degree holders in computer-related occupations by field of study, 1999



Source: National Science Foundation. 1999 SESTAT Integrated Data System. The SESTAT Web site is sestat.nsf.gov.

Many computer and information systems mangers have a master's degree in business administration (MBA) with technology as a core component. This so-called techno-MBA degree differs from a traditional MBA because of its heavy emphasis on information technology in addition to the standard business curriculum. And because computer and information systems managers make not only technology decisions but also business decisions for their organizations, techno-MBA programs are becoming increasingly popular.

Information technology workers interested in becoming a computer or information scientist usually need a doctoral degree in computer science or computer engineering because of the highly innovative and technical nature of the work. Some computer and information systems managers may have a doctoral degree in a computer-related field, demonstrating thorough technical knowledge.

Employers seek IT workers who can interact with others.

Flexible pathways

The discussion about career preparation for information technology occupations reveals that there is no universal education and training requirement for jobseekers in information technology. A computer-related degree may be the easiest and most direct route to take, but it is by no means the only one. There is a variety of ways in which workers can demonstrate the computer knowledge and skills necessary to get a job in one of several computer-related occupations. Practical experience, although difficult to measure and quantify, is important and allows jobseekers flexibility—especially for those who do not have a computer-related degree.

Information technology workers must continually acquire new skills to remain in this dynamic field. To this end, the role of community colleges in educating

and retraining information technology workers should continue to grow in the coming years. A May 2000 Urban Institute report, "The Role of Community Colleges in Expanding the Supply of Information Technology Workers," says that these schools conduct a large amount of information technology training and contribute to retraining both veteran workers and those from other fields.

Technology changes at such a rapid pace that retraining and updating information technology skills is essential, even for workers already in their jobs. The emphasis on nondegree programs, such as employer training and self-study, also will rise in importance. And just as colleges and universities are increasingly using distance education as an efficient and cost-saving measure, organizations are using it to train and retrain their employees in information technology.

There are several ways that individuals may prepare to become an information technology worker. At first glance, the tracks that Maria and Spencer took to get jobs in their respective computer-related occupations might seem unorthodox. Yet with rapidly changing technology and increasingly flexible training requirements, the routes they took should remain commonplace.

For more information

Consult the 2002-03 *Occupational Outlook Handbook* to learn more about specific information technology occupations. Along with training requirements, the *Handbook* provides details about the nature of the work, working conditions, earnings, employment, and job outlook for the following information technology occupations: Computer and information systems managers; computer hardware engineers; computer programmers; computer software engineers; computer support specialists and systems administrators; and systems analysts, computer scientists, and database administrators.

The following organizations also provide information for computer-related careers:

Association for Computing Machinery (ACM)
1515 Broadway
New York, NY 10036-5701
1 (800) 342-6626
(212) 869-7440
www.acm.org

IEEE Computer Society
Headquarters Office
1730 Massachusetts Ave., NW.
Washington, DC 20036-1992
1 (800) 678-4333
(202) 371-0101
www.computer.org

National Workforce Center for Emerging Technologies
3000 Landerholm Circle SE.
Bellevue, WA 98007
(425) 564-4215
www.nwcet.org

Information about the designation of Certified Computing Professional is available from:
Institute for Certification of Computer Professionals (ICCP)
2200 E. Devon Ave., Suite 247
Des Plaines, IL 60018
1 (800) U-GET-CCP (843-8227)
www.iccp.org

Information about training leading to a CompTIA certification is available from:
Computing Technology Industry Association (CompTIA)
1815 S. Myers Rd., Suite 300
Oakbrook Terrace, IL 60181-5228
(630) 268-1818
www.comptia.org

Those interested in earning an IT degree have many options.

For information about training for Microsoft certification, contact:
Microsoft Corporation
One Microsoft Way
Redmond, WA 98052-6399
1 (800) 636-7544
www.microsoft.com/train_cert

Information about training for Oracle certification is available from:
Oracle Corporation
500 Oracle Parkway
Redwood Shores, CA 94065
1 (800) 529-0165
education.oracle.com

For information about training for Cisco certification, contact:
Cisco Systems, Inc.
170 W. Tasman Dr.
San Jose, CA 95134
1 (800) 829-6387
www.cisco.com/warp/public/10/wwtraining

Information about training for Novell certification is available from:
Novell, Inc.
2211 N. First St.
San Jose, CA 95131
1 (800) 233-3382
education.novell.com

You're a what?

Research

When Anne Albertine gets creative in the kitchen, millions taste the results. As a research chef, she mixes good taste with good science, creating recipes for Taco Bell restaurants at its corporate headquarters in Irvine, California. Her tacos, chalupas, and burritos fill the menus of more than 6,500 restaurants. "My team and I make restaurant quality food that can be mass produced," says Anne, "so the culinary quality—the freshness, taste, and texture—has to hold up."

Research chefs, also called product development or food innovation chefs, create new foods for restaurant chains, coffee shops, and food manufacturing companies. They blend culinary training with a knowledge of food science. "As chefs, we can make food that tastes good and has visual appeal," says Anne. "We can weave flavors together." But research chefs also understand food preservation, mass production, and the technical terms used by scientists. And they use this knowledge in their recipes.

Research chefs get ideas for new menu items from many different sources. They often use the results of customer surveys to determine what customers crave. Suggestions are general. They might include requests for a large portion size, a low price, or a certain flavor, such as smoky or sweet. Research chefs give the ideas substance by creating several different recipes to match these characteristics. "My job is to create options," says Anne. For every product that makes it to the public, researchers cook up 30 to 100 alternative recipes that never make it out of the laboratory.

Research chefs also find inspiration by following trends in consumer tastes. They sample the menus of fine restaurants, often traveling abroad to stir up their creativity. And chefs read culinary magazines and study cookbooks, searching for recipes to modify.

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With a set of food qualities in mind, research chefs start experimenting with ingredients. Anne often begins her day with a trip to the grocery store. "I pick up fresh ingredients," she says, "then go play in my test kitchen." She might try different styles of chopping, compare grilling an ingredient with frying it, or contrast vacuum-packed ingredients with frozen ones. In one recipe, Anne was striving for the just right level of spiciness and the best type of cheese to give a toasty flavor. She uses her technical expertise to pick ingredients that will taste good when cooked in bulk, under the real world conditions of a restaurant.

Anne's recipes also need to be convenient. To make a burrito that was portable, for example, she decided to grill it. The grilling process seared the burrito so it would stay closed, even when it held more food than the other burritos did.

A research chef's test kitchen is similar to the kitchen of any professional chef, with heavy-duty mixers, salamanders—tools for browning the tops of food—and other gadgets. But a research chef's kitchen is designed for precision. Graduated cylinders stand in for measuring cups, and scientific balances that are accurate to the milligram replace the standard countertop scales. Large-batch recipes have to be detailed and accurate so that they can be reproduced in every restaurant. "We strive for quality and consistency," says Anne.

At each stage of development, recipes are tested with customers. In the first testing session, a focus group of customers might choose among 50 or more pictures and written descriptions of possible menu items. "I let the customers tell me what they like," says Anne. "I'm cooking for them, not myself."

Eventually, focus groups taste samples of the most appealing of the proposed foods. Responses are taken during experiments conducted in sensory labs by food scientists and marketers. Anne observes and learns from these experiments. "People might say a product is too messy, too spicy, or too expensive, so I tweak it," she says. "With food, small changes in ingredients can make a dramatic impact."

When Anne isn't fine-tuning recipes, she meets with other members of the staff. "Development is a collaborative process," she says. Financial experts check a recipe's profitability. Market researchers confirm its popularity. Food scientists concentrate on food safety and other considerations. And training and operations managers ensure that the restaurant crews will be able to make the food quickly and well.

Meetings like these highlight non-food-related skills that research chefs need in their jobs: good communication skills and the ability to persuade. "You have to prove your hunches," says Anne. She gives evidence that her ideas will be successful, especially when they require a large monetary investment, such as new restaurant equipment.

Research chefs who work for food manufacturers instead of restaurant chains perform slightly different tasks. They help food scientists develop flavor additives and prepared and frozen foods. They consult with restaurant chefs to learn what they need and explain flavor possibilities. If the restaurant wants a

chef

by Olivia Crosby

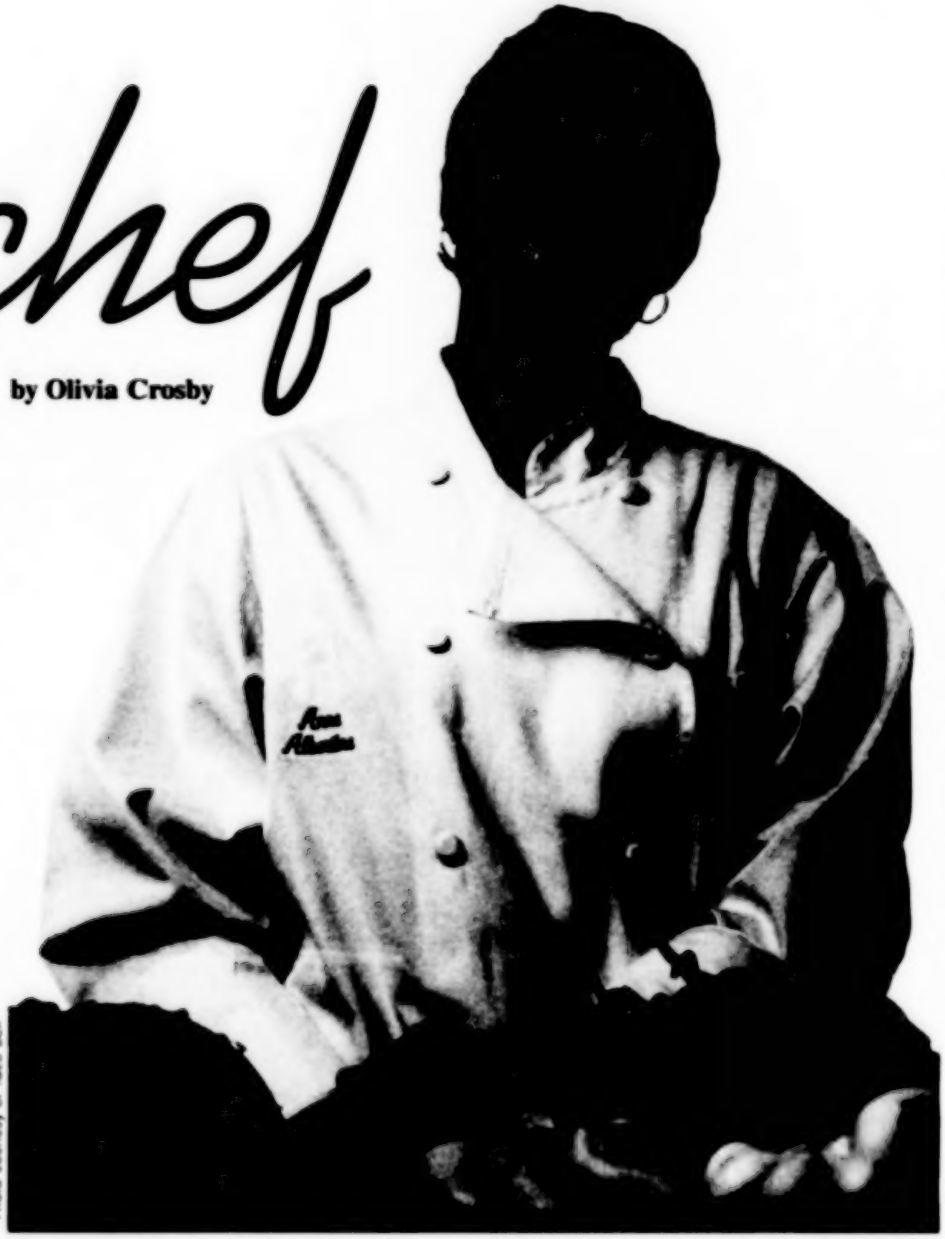


Photo courtesy of Taco Bell

lemon flavor, for example, should it be acidic, sweet, or peely? Should it be liquid or dry? Research chefs translate the specifications of the restaurant into the technical language of scientists. Research chefs also test food scientists' products, using them in recipes to make sure they taste good.

To gain their unique mixture of skills, most research chefs earn a degree in culinary arts from a school accredited by the American Culinary Federation. And they take additional classes in food science and chemistry. Anne received a bachelor's degree in general science and worked in consumer product development before following her love of cooking and getting her culinary arts degree. After graduating, she completed several internships with chefs experienced in fine dining, an experience she recommends highly. "Intern with as many different people as you can," she says. "It's important to learn different techniques and to build contacts in the industry."

The Research Chefs Association offers certification to research chefs who have culinary education, 3 to 5 years of experience in both research and culinary arts, and a passing score on the certification exam. The Association also offers a culinary scientist certification to those who have a bachelor's degree in food science, at least 8 weeks of accredited culinary education, research experience, and a passing score on a written cooking exam.

The Research Chefs Association had almost 1,400 members this year, but the number of research chefs may be higher or lower than that number because not every member is a research chef and not every research chef is a member. According to a survey taken at the association conference in 1999, earnings varied widely for research chefs, but many experienced chefs earned between $70,000 and $90,000 per year. This suggests that research chefs often earn more than other chefs do. The Bureau of Labor Statistics does not collect data on research chefs.

The benefits of working as a research chef extend beyond earnings. Unlike restaurant and cafeteria chefs, who usually work weekends and evenings to prepare meals and supervise kitchen staff, most research chefs work standard business hours. And although they have deadlines to meet, research chefs usually work at a more relaxed pace than their restaurant counterparts.

The chance to be innovative adds spice to the job. "I'm always looking for a new way to achieve something in a recipe," says Anne.

And when a recipe succeeds, research chefs share it with a wide audience. "I love seeing a product go national," Anne says. She also enjoys seeing people eating and liking her creations—and if people discover what her job is, they often tell her which of her menu items are their favorites.

Knowing that her creations are popular adds zest to Anne's work, but the work itself is what she likes best. By mixing a passion for food, a knack for science, and a flair for creativity, she wrote a recipe for a career she loves.

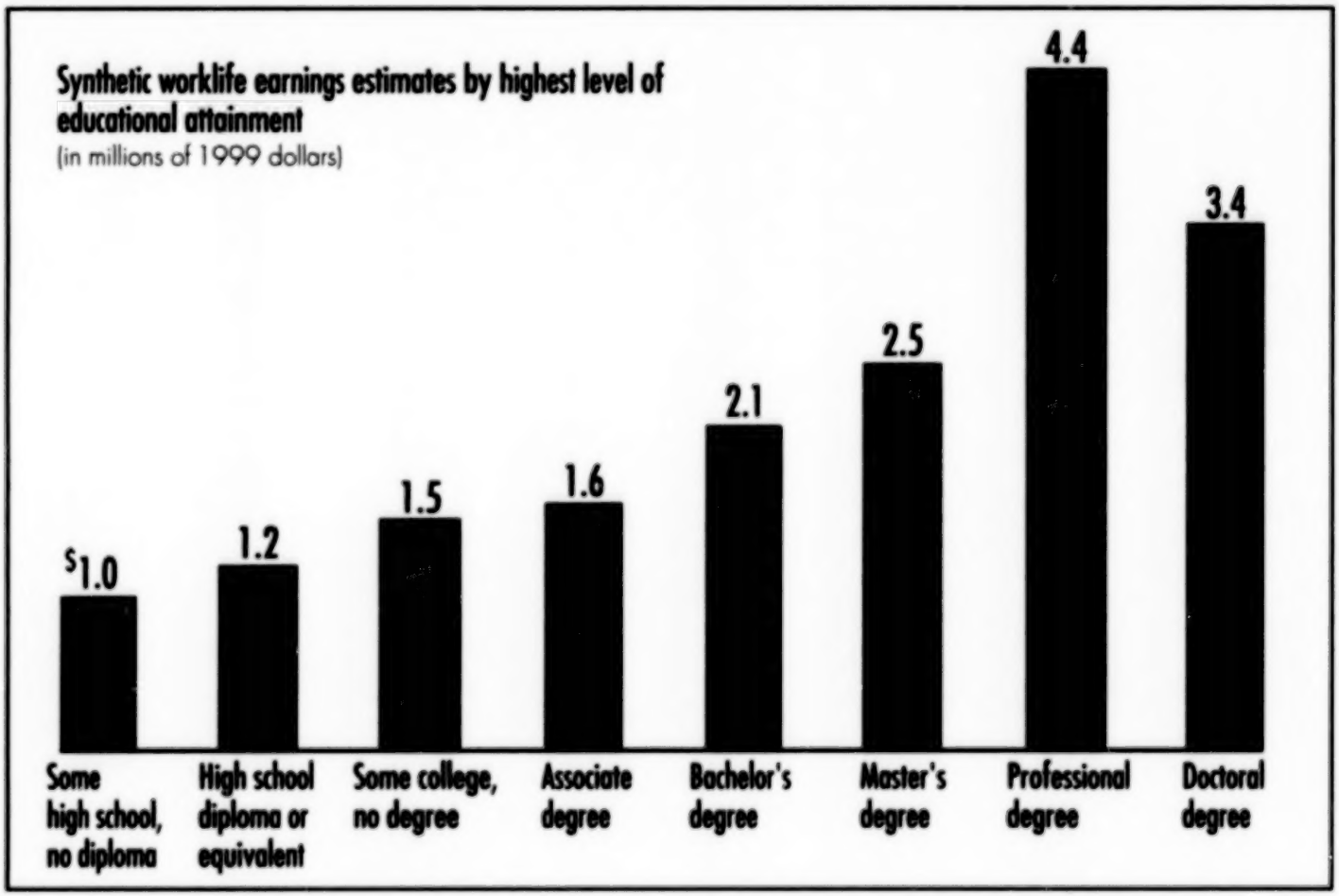
OOChart

More education means higher earnings—for life

A new report from the U.S. Census Bureau underscores the economic value of education: data show that over the course of their working lives, adults are likely to have higher earnings the more educated they are.

As the chart illustrates, high school dropouts have the lowest expected lifetime earnings compared with workers at all other levels of educational attainment. Professional and doctoral degree holders have the highest. And financial gains are predicted at each successive level of schooling completed in between.

Educational attainment alone does not determine an individual's earnings potential over his or her lifetime, however; these estimates are group averages that assume full-time, year-round employment throughout a 40-year work life. Other factors—including occupation, field of study, and work experience and continuity—may significantly affect a specific worker's income. For a more detailed discussion of earnings for college graduates, see "College at work: Outlook and earnings for college graduates" elsewhere in this issue of the *Occupational Outlook Quarterly*.



Source: U.S. Census Bureau, "The Big Payoff: Educational Attainment and Synthetic Estimates of Work-Life Earnings," Current Population Reports, P23-210, by Jennifer Cheeseman Day and Eric C. Newburger, available via a link at **www.census.gov/population/www/socdemo/educ-attn.html**. Data are from March supplements to the Current Population Survey, 1998-2000.

Note: Earnings estimates are for full-time, year-round workers and are based on 1997-99 work experience. "Synthetic" work-life earnings estimates are created by using the working population's 1-year annual earnings and summing their age-specific average earnings for people aged 25 to 64. The resulting totals represent what individuals with the same educational level could expect to earn, on average, in today's dollars during a hypothetical 40-year working life.

END

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